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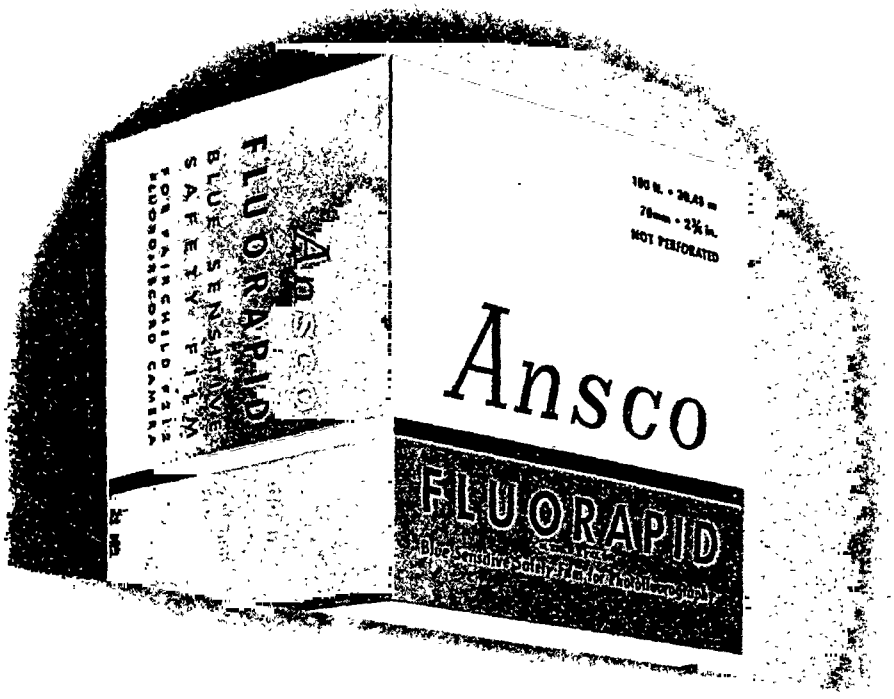
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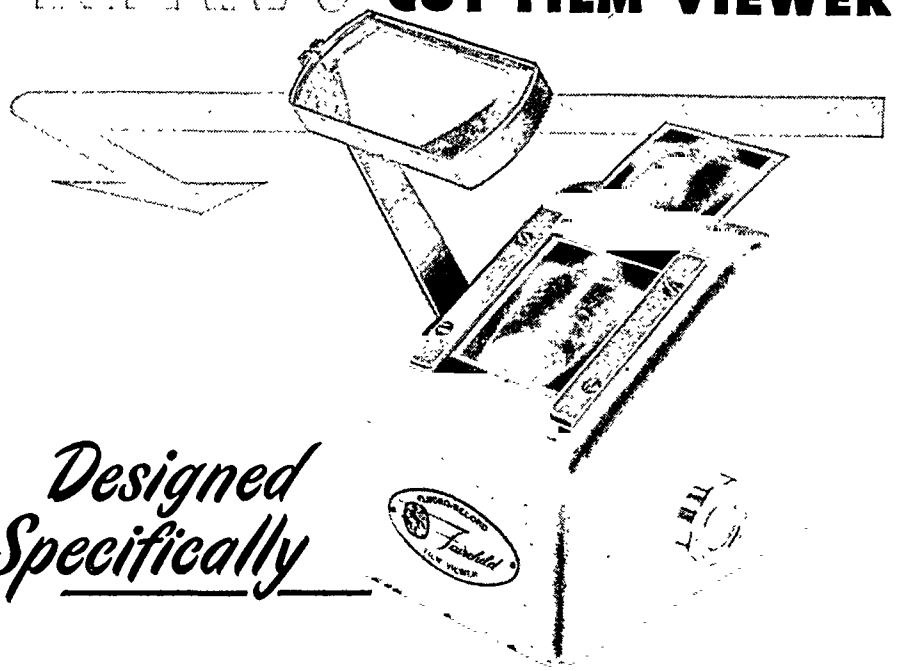
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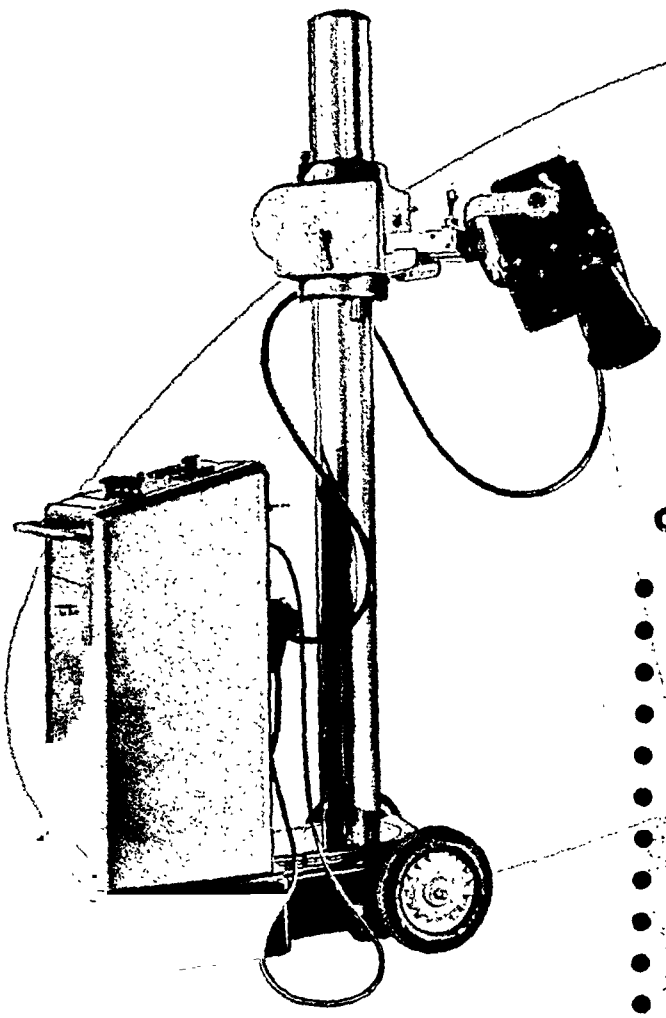
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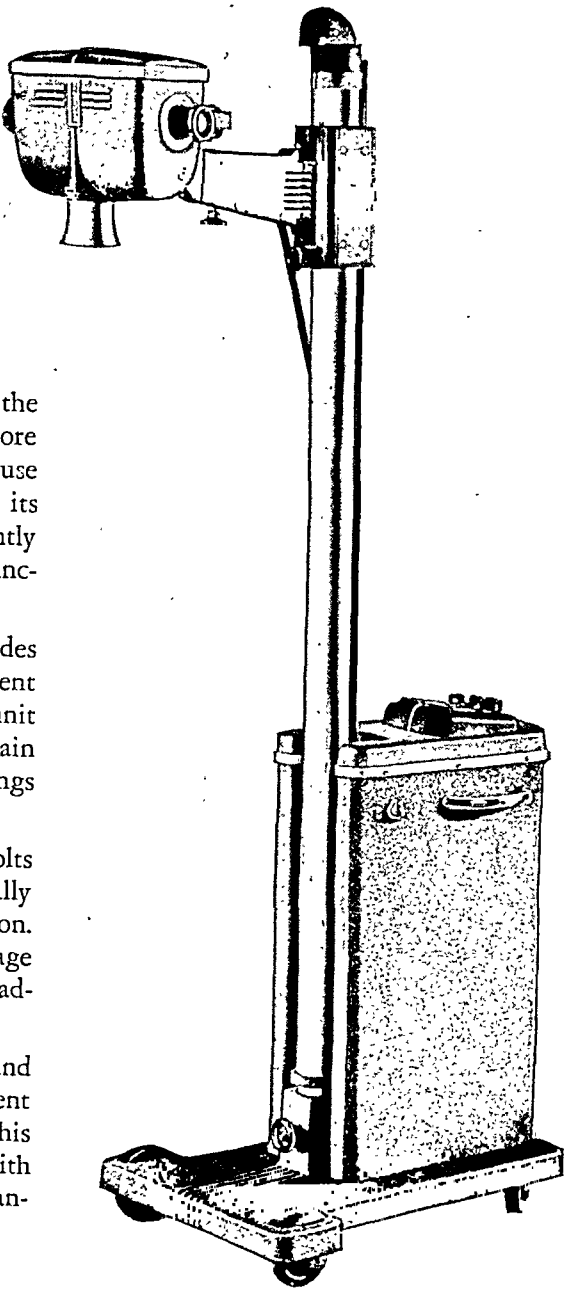
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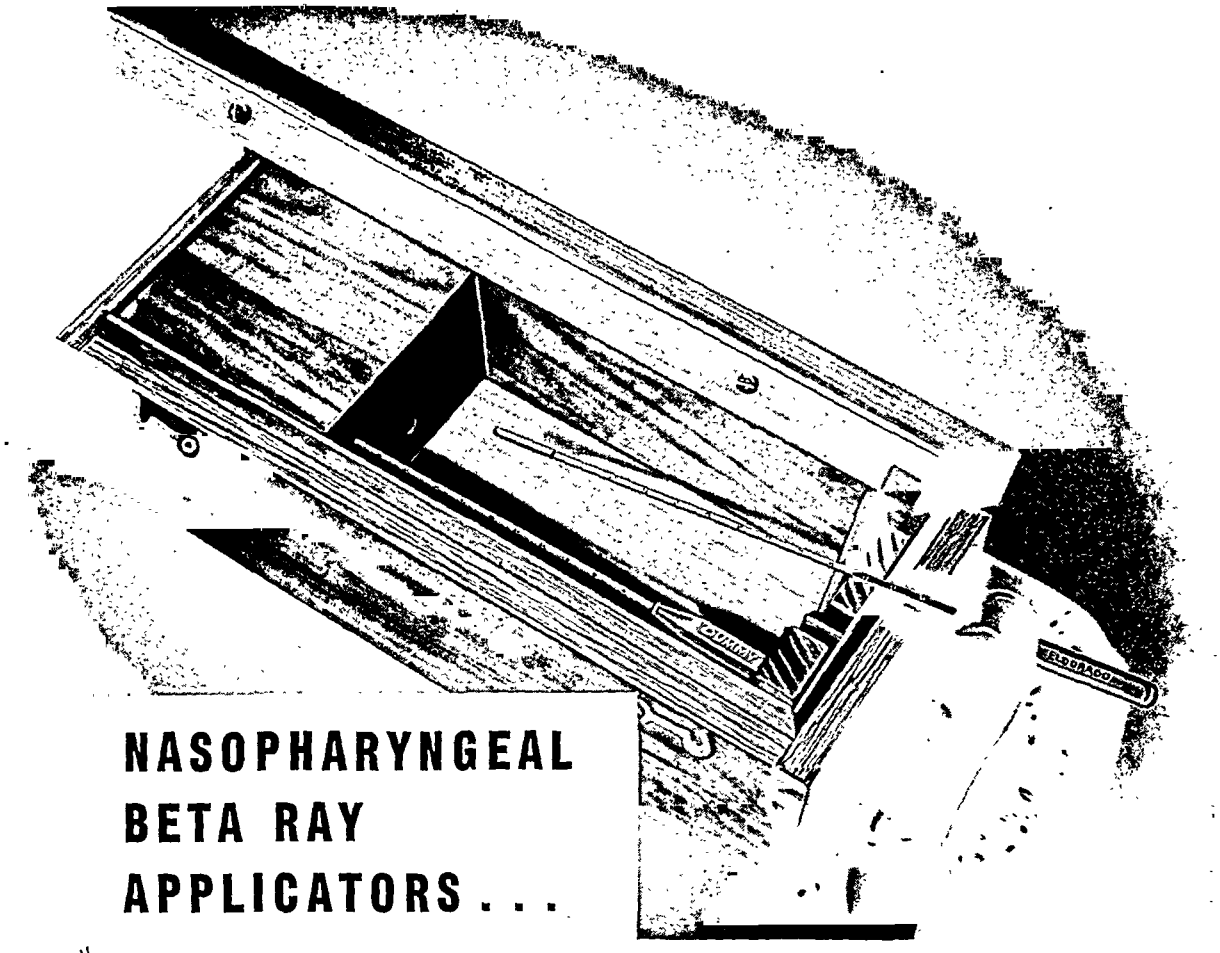
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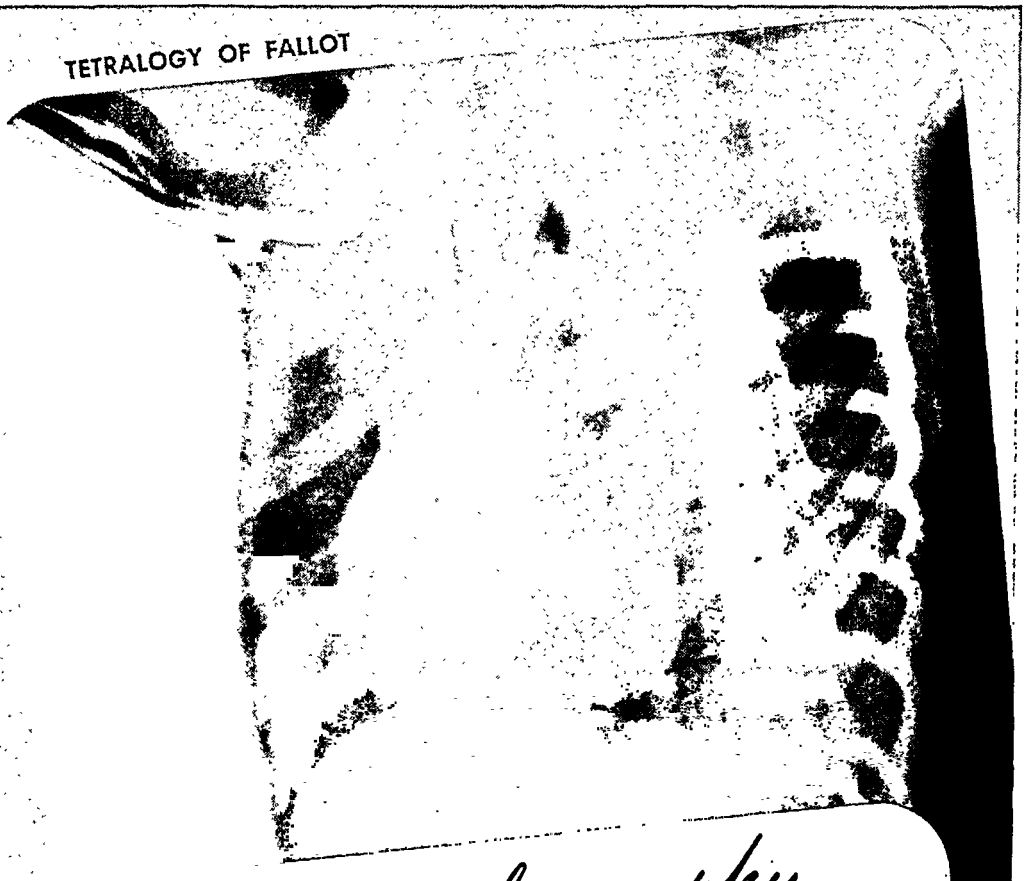
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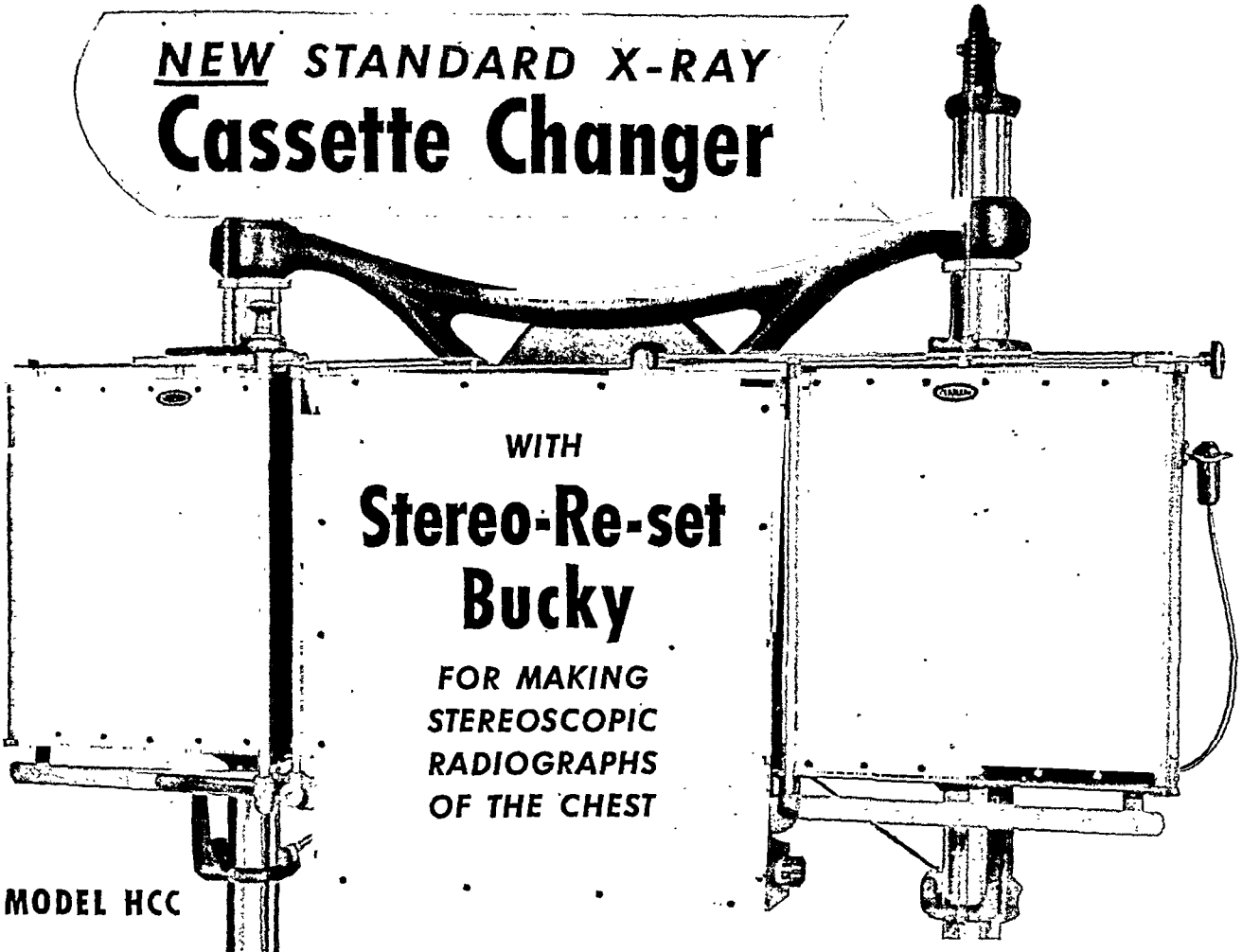
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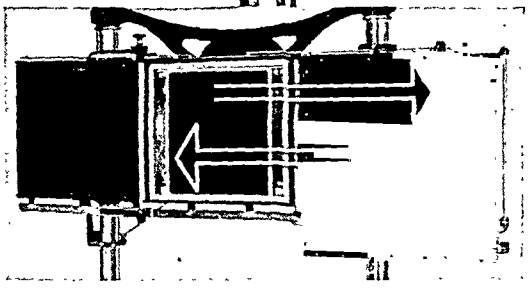


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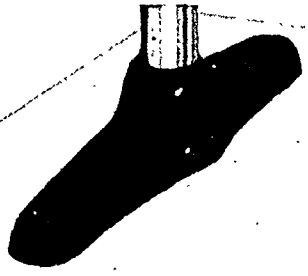


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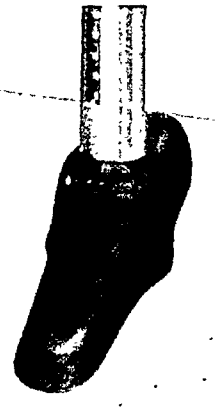
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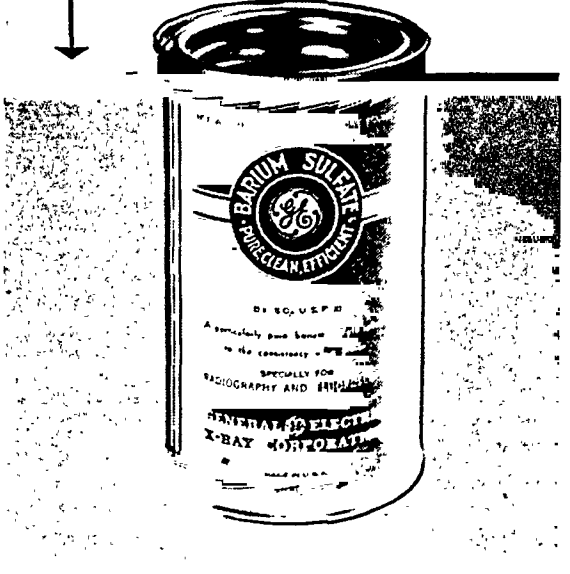
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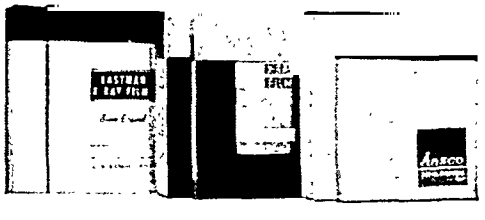
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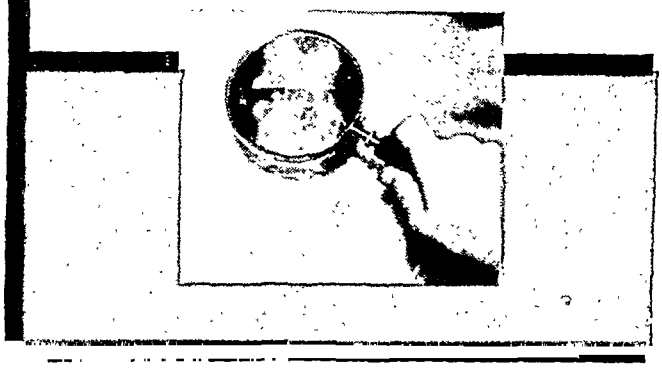
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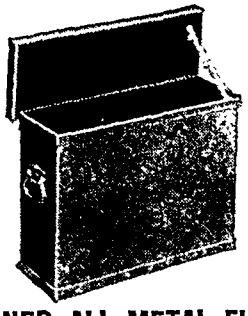
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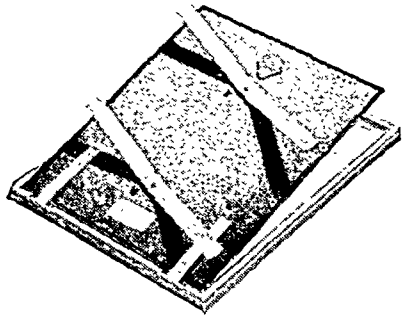




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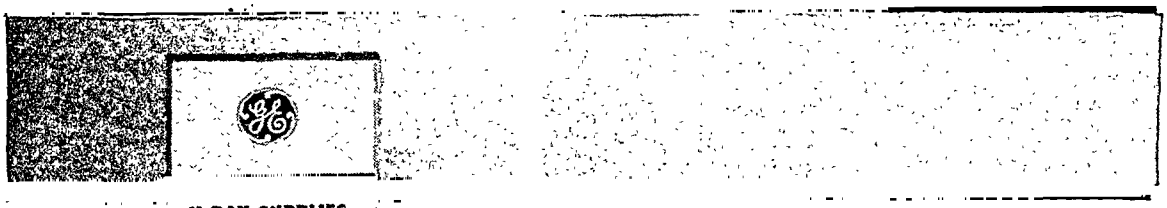
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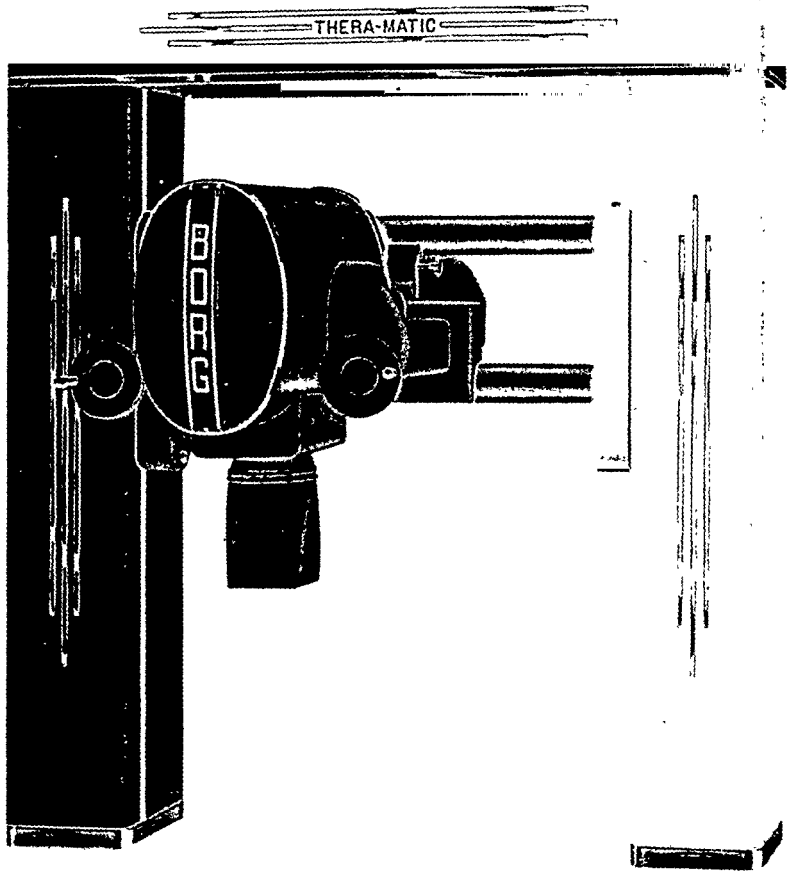
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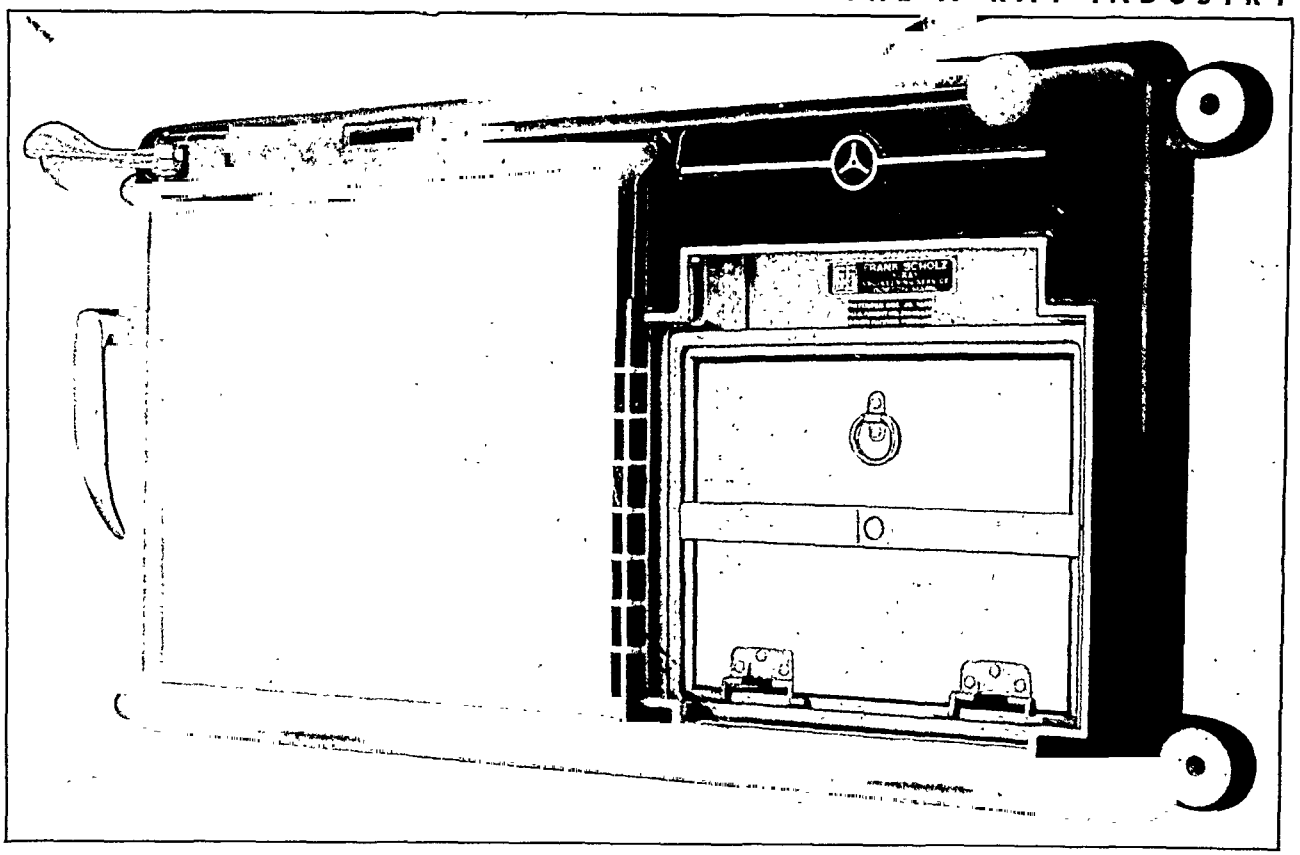
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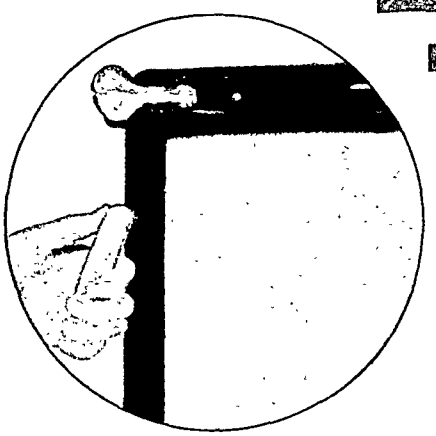
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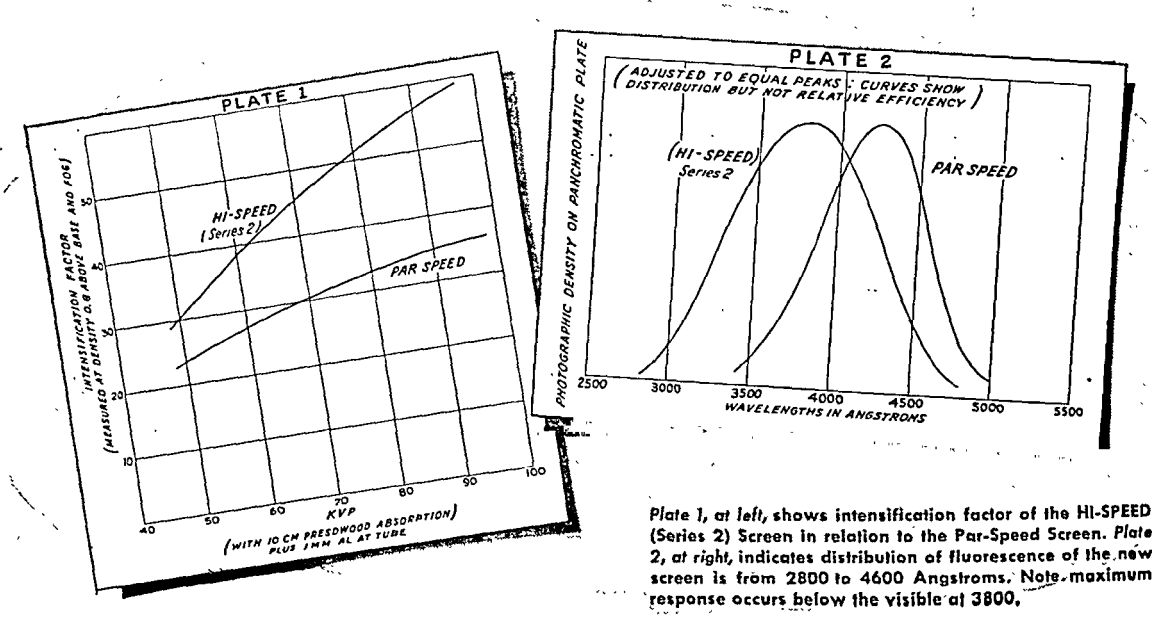


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THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

VOL. 60 JULY, 1948 NO. 1

MICRO-ARTERIOGRAPHY*†

By A. E. BARCLAY, O.B.E., D.Sc. (Hon.) Oxon., F.R.C.P., F.A.C.R.
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OXFORD

IN THE course of experimental work on rabbits, designed to investigate the causation of traumatic uraemia (1946), (1947), our results indicated the need for a close study of the intrarenal vascular system. These results had strongly suggested that, under certain conditions, blood circulating through the kidney was taking a route other than that generally attributed to it; more specifically, that it was taking a short cut from the arterial to the venous side, leaving the cortex either partially or completely ischaemic. The observations, which were obtained by the use of various experimental techniques (arteriography, including direct cineradiography; direct observations of colour changes in the surface of the kidney and in the blood of the renal vein; injections of dyes) seemed to admit of no other explanation. The application of ordinary radiographic techniques to kidneys injected with contrast media, while demonstrating the vascular system as a whole and the altered distribution of the intrarenal blood in special circumstances, failed to show any direct arterio-venous communications of a size visible to the naked eye, and, because of inadequate definition, provided no information as to the smaller vessels in the region in which anastomoses were suspected. It was this limitation of the ordinary techniques that stimulated us to attempt the development of a method for demonstrating radiographically the more minute vascular structures.

The need for finer detail in radiographs [to show the calciniferous glands in worms; Robertson (1936)] had been adequately met by the use of lantern slides instead of X-ray film. Apart from this we had no experience, nor did we know at that time of any papers on the subject except that of Lamarque (1938), who had succeeded in showing the microscopic detail of histological specimens in amazing detail. This intricate technique, however, was unsuited to our needs, for it was not only too complex but was designed to give detail of tissue structure that would merely obscure the picture we desired, *i.e.*, a radiograph that showed the opaque material in the vascular system uncomplicated by other shadows. We, therefore, pursued our investigations with such means as we had at our disposal, achieving in a few

* A preliminary note of the technique was published in 1946; Barclay, A. E., Daniel, P., Powell, H. M., and Prichard, M. M. L. "Radio-micrography," *Journ. Physiol.*, cv, 28–29.

† Reprinted by permission from the *British Journal of Radiology*, 1947, *20*, 394–404.

weeks, on an experimental basis, the type of result we aimed at. Owing to war conditions we were quite unaware that several continental workers had already explored the ground and obtained similar results. Bohatyrtschuk (1944) gives a full history and bibliography of the progress that has been made on the subject. He also carried out a considerable number of experiments



Fig. 1. Radiograph of a slice of injected rabbit's kidney enlarged ×3.

with micro-arteriography, noting the effect of drugs and of heat and cold. The technical conclusions at which we arrived are very similar to those obtained by these other workers, whose main interest lay in the development of the technique. They explored in detail the physical and chemical factors involved. We, on the other hand, merely experimented with such facilities as lay at hand and found that with relatively simple means we could fulfill our more limited requirements. We were fortunate, however, in that a photographic film that met our needs had become commercially available, while these workers had to make their own emulsions for the purpose. By comparison, our problem was simple for, whereas they aimed at the differentiation of cellular elements differing little in atomic weight and therefore in ratio-opacity, we aimed only at differentiation between normal tissue and radiopaque material, *i.e.*, between elements that are near the lower and upper limits of the atomic series. For our purposes there was no need to use the very soft radiations, bordering on Grenz Rays, essential in the differentiation of tissues.

We had already radiographed many injected kidneys, and slices of such kidneys, on photographic materials normally available (Fig. 1), but, as already stated, the closest study of these stereoscopic pictures failed to show any indication of the anastomoses we suspected. These must, therefore, lie in vessels too small to be seen unless considerably magnified. Owing to the grain of the X-ray film, our radiographs could not be enlarged by more than a few diameters, and we decided to explore the possibilities of using photographic material of much smaller grain size in order that the radiographs could stand enlargement. We also decided to explore the radiographic effect of utilising much softer types of rays than could pass through the glass wall of an ordinary X-ray tube.

Photographic emulsions

For our investigation, four types of photographic emulsion were used:

(1) Ilfex: a radiographic film used without intensifying screens. On this film (or on Crystallex, a similar type of film but of rather finer emulsion), most of our exsected specimens had been radiographed.

(2) Process: a type of emulsion employed for lantern slides and contact film reproduction. The grain size of this emulsion is very much less than that of Ilfex.

(3) Kodaline: a film that was much used during the war for photographic recording in miniature of documents, plans, etc. The grain size of this emulsion allows very considerable enlargement.

(4) Maximum Resolution: a new type of film* that is capable of carrying an image that may be greatly enlarged. It is reputed to be capable of resolution to 1,000 lines.†

The sensitivity of photographic emulsions is closely linked with the grain size; the finer the grain, the greater the exposure that will be necessary. If, in round figures, Ilfex requires a factor of 1, Process will need 20, Kodaline 200, and Maximum Resolution 2,000 times the exposure, *i.e.*, an exposure of 1 second on Ilfex would need about 30 minutes at the same settings to obtain equivalent exposure on Maximum Resolution film.

For the detailed study of even the larger vessels of an organ so small as a rabbit's kidney, the radiographic image must be very considerably enlarged. To see capillaries with the unaided eye, these have to be enlarged by about 35 diameters. But enlargement by only two or three diameters made the grain of the Ilfex film so obvious that it obscured all detail. Still using the ordinary X-ray tube, we then tried Process film. This showed a marked increase in detail, and Kodaline gave still further improvement. Nevertheless, the results would not stand much enlargement and, moreover, they were grey and lacking in contrast. Maximum Resolution was also tried, but the exposure factor was so high that it was difficult to obtain even a faint image.

Use of softer rays

Ordinary X-ray apparatus is usually provided with controls that allow the use of radiations down to about 40 kV. The glass wall of ordinary X-ray tubes is said to be equal in density to about 1.7 mm. of aluminium, and therefore filters out most of the softer radiations in the composite beam that come from the target. Such rays, although likely to be of value for thin sections, are of no value in clinical radiography, as they could never reach the film. Hence the beam from an ordinary X-ray tube, even at its lowest setting, would be too deficient in the softer wave lengths to be of much value for our purpose. Experience had shown that even with relatively thick slices of specimens it was difficult so to adjust the exposure as to obtain even a faint shadow on our radiographic materials. The margin of error was small and the actual detail poor, even allowing for the graininess of the film. What was needed seemed to be a bundle of X rays that was very rich in those of long wave lengths, *i.e.*, an X-ray tube that was fitted with a window of low density. Tubes of this type are in routine use for diffraction work in crystallography departments. They are fitted with aluminium foil or other type of window of low atomic weight, such as beryllium or lithium. The early tubes of this type were frequently home-made and connected to a pump by which they were exhausted to the required vacuum. They could be repaired very easily and at small cost, and on the score of economy and also because hot cathode tubes were in short supply such tubes have remained in use.

When we asked for help from the crystallography department, hot cathode diffraction tubes were not available owing to breakdowns and the impossibility of replacing them at the time. It was, therefore, with one of the home-made gas tubes that our first experiments were made. Such tubes are difficult to manage at low voltages as they tend to reverse. Although we obtained excellent results with the gas-filled diffraction tube, we did not learn the art of its management for radiography sufficiently well to be able to control our results. The output of the tube was low and with Maximum Resolution film the ex-

* For convenience we have now replaced films with glass plates as they are more easily handled.

† Since this was written we have been supplied with Kodak 050 type MR plates, emulsion No. 1565. The grain size of this emulsion appears to be smaller than that of Maximum Resolution.

posures ran into several hours. Nevertheless, it is likely that a skilled worker who has learned the art of tube management would be able to attain excellent results in this type of work even with a coil outfit and this cheap and easily repaired tube.

For our first trial in radiographing a section of tissue with the gas-filled diffraction tube we used Process film. The result was startling and showed detail of an order that went far beyond what we had thus far attained. Kodaline film used with this tube gave even greater detail; it seemed, in fact, to come well within measurable distance of recording vessels of the smallest size. With Maximum Resolution film we were able to obtain radiographs that seemed completely to meet our needs, *i.e.*, to show vessels down to those of capillary size.

Our results with the gas tube were so encouraging that we decided to install apparatus designed specially for this class of work. A half-wave transformer happened to be available and this was coupled up to a Machlett shockproof hot cathode diffraction tube. This apparatus gives accurate control at from 5 to 50 kV, and up to 20 mA. The tube has a molybdenum target, is water cooled, and runs continuously and steadily at 20 mA at any required voltage. It is fixed horizontally above a table and has two beryllium windows that are set approximately at 180° to each other. Normally it is used with the windows giving horizontal beams, but, if needed, it rotates to give a vertical beam for radiographing objects on the table, or thick and heavy specimens which would not be easy to fix in the vertical position.

In the design of any apparatus that must record fine detail, the elimination of vibration is essential. To provide a heavy concrete foundation is expensive, and we decided to try and eliminate vibration from outside sources by making the apparatus self-contained. To this end, a casing was made to enclose the tube head. Corresponding to each of the windows of the X-ray tube, this casing was threaded to take brass cones tubes of $2\frac{1}{2}$ in. diameter and of various lengths that screw firmly onto the tube-head housing. The cassettes that carry the film fit snugly and firmly onto the end of these brass tubes. Thus the unit is not only self-contained and unaffected by external vibration, but is also self-contained as regards X rays. Hence, the room in which this apparatus is used also serves as the dark room—a great convenience and time saver in this class of work.

The focal spot of the gas tube we used in our first experiments was of the order of 0.5 mm. Our hot cathode tube has a focal spot of about 1.0 mm. So far as we can determine, this increase in size has no appreciable effect on the sharpness of even relatively thick sections at the distance of 8 in., which we most frequently employ.

Technique

Naturally the radiographic factors vary with the thickness of the specimen. Complete injected rabbit kidneys or brain, for example, give good results when radiographed at the higher voltages. The results obtained when whole organs or thick slices are radiographed are well in advance of anything possible with an ordinary X-ray tube, particularly if Kodaline film is used. Such radiographs taken stereoscopically can be enlarged either in whole or in part and viewed in an ordinary stereoscope, and are of considerable value in giving the general pattern of the vascular system in an organ. But it is from the radiographs of sections of injected organs, to which the radiography of the whole organ is the prelude, that the main value of the technique appears to lie in research work. For this purpose the organ is injected with radio-opaque material, *in vivo* or after excision, and is fixed in formal saline in the usual way. After radiographing the whole organ, sections are made in the direction indicated that will give the maximum vascular pattern for study. These may be of any thickness. It is not advisable to cut the sections too thin as the radio-opaque ma-

terial tends to fall out. With this technique, a thicker section than is usual in histology is indicated, since it gives a greater length of vessels before they pass out of the section. On the other hand, if a section is too thick, the resulting radiograph may be too full of vessels and therefore too confused even for stereoscopic studies. Sections of 120μ to 450μ seem to be suitable in thickness. Such sections, although thick for histology, may serve a dual purpose, *i.e.*, the radiograph of the section showing only the vascular elements may be studied alongside of the same section stained or injected for histology.*

Mounting the specimen

In order to obtain the maximum of detail recorded on the radiograph, the specimen should, theoretically, be in direct contact with the emulsion, which introduces the complication of floating the specimen into position. For the purpose, we employed 50 per cent glycerine in water in order to reduce the chance of shrinkage from evaporation in transit to the crystallography department and during the long exposures of our early work. We found, however, that Maximum Resolution film was so much reduced in sensitivity when wet, even with water, that it was an entirely unsatisfactory method. Bohatyrtschuk employs 3 per cent. gum arabic, but this had the same effect on the film we employ. Although this intimate contact may be ideal for showing the very finest detail, the question arose as to whether it was essential for the type of work in which we wished to employ the technique, and in which a magnification of 40 diameters was all that was aimed at. There is a definite formula for blurring that takes into consideration (1) the size of the focal spot, (2) the target-film distance, and (3) the object-film distance.† Provided that the target-film distance is considerable and that the focal spot is not unduly large, would it be feasible to mount the specimen on grease paper that would be placed on top of the film? This would be an easy technique, but it would interpose the thickness of the paper and, moreover, the paper might not lie flat; but the simplification of the technique would outweigh and slight disadvantage if this method of mounting could be employed. We therefore persisted with our experiments and found that even the best grease paper is slightly hygroscopic and tended to buckle during a prolonged exposure, thereby causing movement. Cellophane was worse in this respect. The most satisfactory waterproof material we have yet found is the tissue supplied for heat mounting of prints.‡

It is a simple matter to test the blurring effect of mounting the specimen on paper. A small piece of the paper is placed on part of a film which is then sprayed with bismuth carbonate dust from an insufflator. An exposure is then made and the resulting radiograph is either examined under the microscope or photographically enlarged. We found that the degree of blurring caused by the interposition of the paper was so slight that it was imperceptible at the target-film distance of 8 in. that we employed in the test.

For mounting the section on the tissue, it is washed in water and then placed in 50 per cent. glycerine and water to prevent evaporation when low voltages and consequent long exposures are employed. If the exposure is not more than a few minutes, this procedure may be omitted. The section is then transferred to the correct position on the tissue so that it is automatically in

* See, for example, Fig. 31 in "Studies of the renal circulation."

† Franke's formula for blurring: (quoted by Bohatyrtschuk)

$$W = \frac{bd}{F-b}$$

when W = blurring;
b = distance of object from the film;
d = size of the focal spot in mm.;
F = target-film distance.

‡ The tissue mounting we now employ is "Stryafoil" which is an extruded polystrene film and is completely impervious to moisture. It casts virtually no shadow at 20 kV and even at lower voltages is hardly seen. The only difficulties are the electrostatic properties and I suspect that there is a tendency for the tissue to "dance" with the bombardment of the rays if the mounted section is a thin light one. Doubtless some way will be found to overcome this if it does in fact exist.

the centre of the field. The surplus fluid having been removed with blotting paper, the tissue carrying the specimen is placed on the film in the cassette, the front of which holds the tissue flat and in position.

We should have expected that the higher



Fig. 2. Contact print of a radiograph of a section (240μ) of a rabbit's kidney, injected with radiopaque material.
Factors: Crystallography diffraction tube, with beryllium window; kV 15, mA 20, distance 8 in.; Maximum Resolution plate (Kodak 050 type MR plate, emulsion No. 1565); exposure 13 minutes.

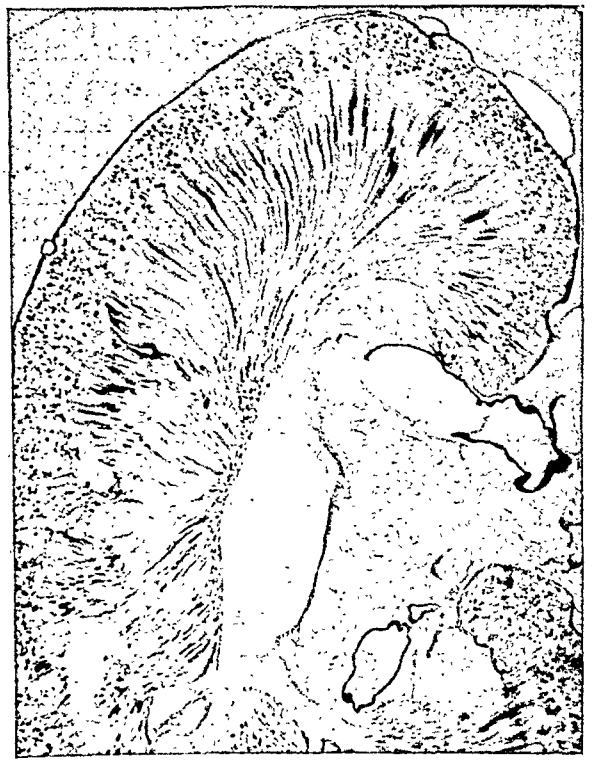


Fig. 3. Enlargement (×4) from radiograph, Fig. 2.

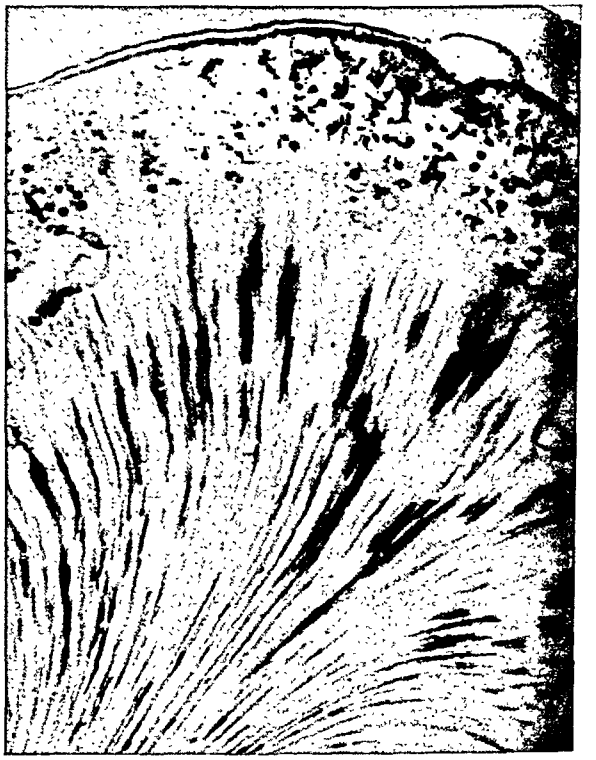


Fig. 4. Enlargement (×15) from radiograph, Fig. 2.

voltages, say 40 or 50 kV, would have "killed" such fine detail as capillaries filled with thorotrast. We found, however, that for this work there is very considerable latitude, and although the fine detail of injected vessels is best shown at about 15 or 20 kV, the structure of the tissue being "killed," it is still well shown even at 50 kV if the negative is not overexposed. The advantage of using the highest efficient voltage lies in the shorter exposure and the consequent reduction in movement that might come from absorption of moisture into the mountant tissue and consequent buckling, a feature that is reduced but not abolished by the use of glycerine. At 8 in. and 20 kV and 20 mA, our exposures for a section of 240μ on Maximum Resolution film are of the order of 5 minutes; at 30 kV the exposures are $1\frac{3}{4}$ minutes.

Injection media

We have used a variety of substances more or less experimentally.

(1) *True solutions:* Practically all of those employed in arteriography—

diodrast (perabrodil), uroselectan, pyelosil, etc.—depend on their iodine content for their opacity. Since they diffuse from the vascular system they are not suitable for micro-arteriography preparations.

(2) *Colloidal preparations:* The particles of colloids are small; those we have employed, although they flow freely through the capillaries, do not pass



Fig. 5. Photo-micrograph (×50) of radiograph. Taken from cortex of kidney, Fig. 2, showing the glomeruli, afferent and efferent vessels, and the subcapsular network of capillaries.

through membranes and are therefore satisfactory from the point of micro-arteriography.

Thorotrast is the best known and most widely used of these colloids. It mixes freely and circulates with the blood; it is non-toxic, does not affect the blood pressure, and is a most satisfactory injection medium both for injections *in vivo*, and for micro-arteriography. It is colourless, and for this reason we have sometimes combined it with Indian ink or some staining material in order to observe the course of the injection.

Colloidal metallic gold (red) 10 per cent.: This is a very satisfactory medium which not only flows freely but has a rich maroon colour that is useful for microscopical study.



Fig. 6. Enlargement (×5) of a group of glomeruli from photomicrograph, Fig. 5, *i.e.*, an enlargement from Fig. 2 of ×250.



FIG. 7. Photo-micrograph (×50) of radiograph. It shows the capillary network in a fragment of detached membrane in the pelvis of the kidney in Fig. 2.

Colloidal silver iodine (*approximately 10 per cent.*): This also is very satisfactory for filling the finest vessels. It has a light orange colour, is said to be non-toxic, and might be used for *in vivo* injections. It seems to flow even more readily then colloidal gold, but does not appear to "set" well in the vessels and tends to fall out when sections are cut. We are informed that the addition of 3 per cent gelatine would not affect the colloidal state of the injection mass.

Colloidal metallic bismuth: This is an intensely black mass and is also satisfactory from the radiographic point of view, but we found that the samples employed in our earlier work did not flow freely into the capillaries. Seemingly, the preparation we worked with did not remain in colloidal state, as the bismuth settled to the bottom of the bottle. On examining the precipitate under the microscope we found that the particles had agglomerated into masses of considerable size that would clearly not pass through capillaries. On adding "Wettal" (which alters the surface tensions in the fluid) and shaking, the size of the agglomerations was reduced to about 10μ. This, therefore, would be a very suitable injection mass when it was desired to show the arterial side as far as the capillaries. We now also have new preparations of bismuth which retain their colloidal state, and which—like the thorotrast, gold and silver—should pass through the capillaries to the venous side.

(3) *Insoluble metallic salts:* The most suitable that we have tried are bismuth carbonate, red lead, and jeweller's rouge. The particles have a tendency to agglomeration that results in uneven filling even of vessels of considerable size. Of these three insoluble salts, the jeweller's rouge will probably prove to be the best as the particles are small and tendency to agglomeration seems to be least marked.

(4) *Rubber Laxtex* injections may also be used. The X-ray density of the material we employ (571 Neoprine Laxtex. B. B. Chemical Co. Ltd. Leicester, England) gives satisfactory radiographs of larger vessels provided that the kilovoltage employed is kept down to say 20. It may well be that this injection mass will be of considerable use in that the radiograph will guide the study of the actual neoprine preparation.

Other questions than the mere size of particles and their tendency to agglomerate enter into the problem of the suitability of an injection mass for a given purpose, *e.g.*, the density and the molecular weight. So far as we have gone, it has merely been a case of trial and error.

Cassettes

On the front of the cassette a short wide metal tube is fitted. This slips over the brass cones of the X-ray tube and holds the cassette in position. The cassettes are open to the X-ray tube and therefore have to be applied to the cone in the darkroom. In this way the maximum use is made of soft rays. The back of the cassette is lead covered so that, when in position, there is no escape of X rays.

Target distances

The arbitrary standard distances available are governed by the length of the cones. These give $3\frac{1}{2}$ in., 5 in., 8 in. and 13 in. At $3\frac{1}{2}$ in. the cone of rays is small, and at 5 in. it does not cover the diameter of the cone uniformly. These shorter distances will only be used if it should be necessary to employ very soft radiations, which would be much obstructed by the air column. Normally, 8 in. seems to be satisfactory for specimens of up to 500μ thick, but for thicker slices or for complete organs the full 13 in., or even placing the specimen on the table at 19 in., is an advantage, particularly when making stereoscopic radiographs.

Enlargements

Fig. 2 is a contact print from one of the radiographs of a section. To make enlarged prints of these negatives (Figs. 3 and 4) calls for a first-class lens. Standard apparatus is usually only designed to enlarge up to about ×8. We have made enlargements with such apparatus up to ×28, but beyond a certain point (probably not much more than ×8), the resolving power of the lens fails and, apart from increase in the size of the enlargement, there is no increase in detail. If satisfactory enlargements of ×40 could be made in this simple way, the capillaries would be shown and we should obtain a large scale map of every filled vessel in the section.

Fortunately, however, where the ordinary enlarging apparatus fails, the microscope comes to our aid. Just as histological sections can be photographed through a microscope, so also the radiographic negative can be photographed. To our great surprise we found that when we took such a photo-micrograph of a small area of a radiograph, enlarged ×50 (Figs. 5 and 7), there was a greatly increased degree of detail compared with that which could be obtained at much smaller magnification by the enlarging apparatus. The detail was such that we decided to try enlarging these



Fig. 8. Enlargement (×5) of photo-micrograph, Fig. 7, *i.e.*, an enlargement from Fig. 2 of ×250. These vessels measure 3 mm. in diameter; *i.e.*, the actual vessels are 12μ in diameter; in another similar radiograph the vessels are 8μ.



Fig. 9. Enlargement of radiograph of section of cortex of human kidney (×12).

photo-micrographs. The result is shown in Figs. 6 and 8, and it represents a magnification of ×250. It looks as if higher magnifications might still show even more detail, and that the limit of magnification with adequate detail has not yet been reached. Magnifications of this order would show nuclei and elements of the cell structure, comparable to those shown by Lamarque, if the radiograph had been made for this purpose, *i.e.* if the softest rays had been employed. Whether or not the 5 kV available with our apparatus will be low enough for the purpose we do not yet know, as this is beyond the range, we aimed at.



Fig. 10. Enlargement ×240. Taken from cortex of human kidney (Fig. 9) showing glomeruli and some of the surrounding capillary network.

The great advantage of the enlarging apparatus for magnification is that it gives a picture of the whole section or organ with one exposure on a large sheet of printing paper, but the limit of efficient enlargement by this method does not extend far beyond ×10, and even at this magnification the detail seems to fall off. The microscopic method, on the other hand, gives wonderful detail at high enlargements, but is limited to a small area at a time. Such enlargements could, of course, be pieced together

to give a vast picture showing the whole section of the organ.

The application of the technique is simple and rapid. It requires little skill beyond that of ordinary photographic competence, and can be carried out by an intelligent assistant when once the factors have been worked out.

This technique can be employed analytically. Radiographs of the whole organ, suitably injected, can be taken stereoscopically. From the study of these the general run of the main vessels through the organ can be determined and a slice can then be cut in such a way that it includes these. This slice again can be radiographed stereoscopically to determine the plane in which sections will best show the pattern of the detailed distribution. Serial sections of about 240μ are then made in this plane and are radiographed and then enlarged in the usual way, or, for greater detail, enlarged by photo-micrography. Thus the picture of the vascular supply of the organ can be built up as a whole.

SUMMARY

A technique is described for the radiography of sections of organs injected with radio-opaque material. Success depends on two factors, *i.e.*, a photographic film that is virtually grainless, and the use of radiations of long wave length. These radiographs are highly selective, showing virtually nothing except the radio-opaque material in the vessels. They can be magnified by simple enlargement onto ordinary photographic paper by about 10 to 15 diameters, giving the vascular pattern as a whole and thus forming a link between the macroscopic and the microscopic methods of study. Capillaries, however, are not seen at a magnification of ×15, but if photo-micrographs are taken of the radiograph, a magnification of ×50 gives the detail of capillaries and of every injected vessel. There is so much detail in these photo-micrographs that they can be magnified ×5 in the enlarging apparatus direct onto photographic paper of adequate size, giving a total enlargement of ×250.

ACKNOWLEDGMENTS

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THE ROENTGEN DIAGNOSIS OF DIFFUSE LEUKEMIC INFILTRATION OF THE KIDNEYS IN CHILDREN*

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IT IS well known that leukemic infiltration of the kidneys is quite frequent, and in a series of 123 fatal cases of leukemia reported by Kirshbaum and Preuss[7], 63 per cent showed definite leukemic infiltration of this organ. Very often the infiltration is in the form of nodules, but with considerable frequency it is diffuse and it is this type of infiltration which will be discussed in this paper, as it is probable that small leukemic nodular infiltration of the kidneys cannot be recognized by roentgen examination.

Ramsay[11] reported 100 cases of leukemia in children under eight years of age, in 3 of which it was stated the kidneys were large and easily palpated; in several instances postmortem examination showed a considerable degree of enlargement. Merrill and Jackson[9] cited 11 instances of leukemic involvement of the kidneys in one of which the infiltration was diffuse; another showed heavy subcapsular, periglomerular, and perivascular tumor cell infiltration involving a large part of the cortex but almost absent in the medulla. In the others, the infiltration was evidently of the focal variety. Barney[2] noted kidney involvement in 18 of 23 cases of lymphoblastoma of the urinary tract coming to autopsy. Baldridge and Awe[1] found microscopic evidence of kidney involvement in 20 of 39 cases with lymphoma, the highest incidence occurring in the lymphocytic type with attendant leukemia. Freifeld[6] reported a case of lymphoblastoma of the kidney in a seventeen year old male, each kidney being enormously enlarged, the right weighing 2,320 grams and the left 2,450 grams with a microscopic picture of diffuse lymphocytic infiltration. White and Burns[12] discussed an instance of marked enlargement of the kidneys in a three week old infant which on pathological examination displayed lymphocytic infiltration of the diffuse type. They also quote Foged[5] who, in writing of leukemic tumors of the kidney, reported a case of bilateral tumor of the kidney in a two year old child with a normal blood picture without splenomegaly or lymphadenopathy. The right kidney was removed and on microscopic examination showed marked, diffuse, leukemic infiltration; later, a typical lymphatic leukemic clinical picture developed. Bell, Heublein and Hammer[3] reported the case of a twenty-two year old male with chronic myelocytic leukemia with enlargement of each kidney which decreased in size at the same time as the blood picture reverted toward normal, following radiation therapy. According to Ewing[4] the kidney is a favorite site for metastases from lymphosarcoma which may take the form of minute foci, bulky masses or diffuse infiltration.

Although diffuse leukemic infiltration of the kidneys does occur in adults, the condition is considerably more frequent in children. Of a series of 50 cases of leukemia coming to autopsy at the Infants' and Children's Hospital, 26 showed the diffuse form of infiltration of the kidneys.

It is conceivable, as in Case 1, that an occasional patient with unrecognized leukemia will be referred for intravenous urography to determine the nature of the large masses within the abdomen. Because of this, and as the roentgen appearance has only occasionally been described, we would like to represent 3 patients with leukemic infiltration of the kidneys, and describe in

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Fig. 1. Case 1. Intravenous urogram fifteen minutes after injection of diodrast showing enlargement of each renal pelvis with marked elongation of the calices and infundibula without actual deformity or filling defect.

detail the rather characteristic picture obtained after the intravenous injection of diodrast.

REPORT OF CASES

CASE 1. L.D., a male infant, aged twenty-three months, was apparently well until seven weeks before admission to the Infants' and Children's Hospital, when small lumps on the head and large masses within the abdomen were noted. These lumps on the head increased in size and number but were never tender and never showed evidence of erythema. The masses in the abdomen were thought to be due to marked enlargement of each kidney. One week before admission, moderate swelling of the parotid gland became apparent. Physical examination on admission revealed multiple, hard nodules in the scalp which were movable and apparently not attached to the underlying periosteum. There was considerable enlargement of the right and moderate enlargement of the left parotid gland. Large, smooth, non-tender masses could be palpated within the abdomen in the position of the kidneys. Examination of the blood on admission showed 5.37 million red blood cells, with 87 per cent hemoglobin; the white blood cell count was 13,200, platelets 179,000 and reticulocytes 2.2 per cent. A differential count of 200 white blood cells showed 36 per cent mature polymorphonuclear leukocytes, 32 per cent "blast" forms, 3 per cent metamyelocytes, 1.5 per cent myelocytes, and 0.5 per cent eosinophils and basophils. There were 7.5 per cent small and 9 per cent large lymphocytes. There were many macrocytic and polychromatic red cells and about 9 per cent of the red blood cells showed definite achromia. The platelets seemed almost normal on the smear. The urine was negative on admission and the non-protein nitrogen was 43 milligrams per cent. The clinical diagnosis was bilateral embryoma of the kidney with metastases, and the patient was referred to the Department of Roentgenology for examination of the skeleton, chest, and kidneys.

Roentgenograms of the chest showed multiple enlarged nodes in the mediastinum; the long bones showed nothing unusual except for multiple growth-arrest lines. The intravenous urogram showed enormous enlargement of each kidney; the enlargement appeared to be symmetrical and the outline of each kidney was smooth. There was no evidence of calcification within either renal shadow. The dye appeared promptly in the five minute film in adequate concentration; each renal pelvis showed considerable enlargement with rather marked elongation of the calices and infundibula without actual deformity or filling defect (Fig 1). No cyst-like defects could be visualized in the outline of the calices to suggest polycystic kidneys. The roentgen diagnosis was diffuse neoplastic infiltration of each kidney, probably leukemic. A biopsy of the scalp was done two days after admission and the diagnosis of leukemic infiltration of the skin and subcutaneous fat of the scalp was made. The cells observed in the biopsy specimen appeared to be well differentiated, somewhat large lymphocytes with a few of the cells resembling lymphoblasts (Fig. 2).

Radiation therapy was given to the enlarged nodes in the chest and one week later the mediastinal shadows were regarded as being within normal limits. Four weeks after discharge the patient was readmitted with symptoms of vomiting, thirst, dyspnea, and marked pallor.

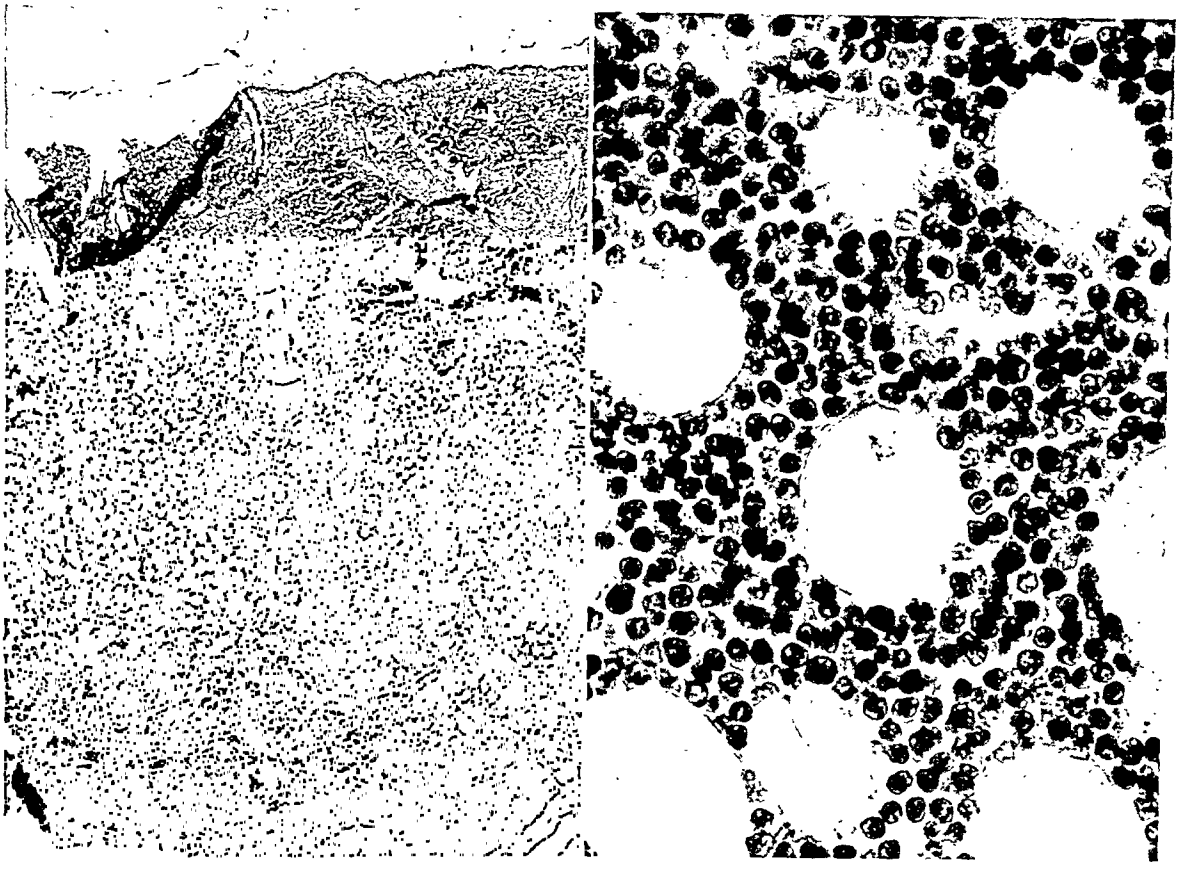


FIG. 2. Case 1. Photomicrograph, leukemic infiltration of the scalp, biopsy.

The child was comatose, there were numerous small hard lumps in the scalp, both parotids were swollen and there were enlarged nodes in the neck, axillae and groins; large bilateral masses were noted in the abdomen. An examination of the blood showed 1.73 million red blood cells and 86,000 white blood cells, the majority of which appeared to be immature lymphocytes of the "blast" type. The patient remained comatose and died five hours after admission. Permission for postmortem examination was not obtained. The final diagnosis was acute lymphatic leukemia.

CASE II. D.F., a white female, aged twelve, was admitted to the Infants' and Children's Hospital with a history of weakness, listlessness, and occasional transient chest pain of one year's duration. Five weeks before entry she was noted to be pale and complained of a cough and of feeling feverish. During the month before entry, she had experienced three slight nosebleeds. Physical examination revealed pallor, small, non-tender cervical nodes, a small right axillary node and a moderately enlarged right submaxillary node. The heart was thought to be enlarged with an apical systolic murmur. The spleen was palpable to the midline of the abdomen at the level of the umbilicus and both kidneys felt enlarged and displaced downward. Examination of the blood showed 37 per cent hemoglobin, 2.0 million red blood cells, 2,400 white blood cells with a differential count of 26 per cent polymorphonuclear leukocytes and 74 per cent lymphoid cells, of which 32 per cent were small and 42 per cent immature lymphocytes. The platelets were 113,000 and the reticulocytes 1.2 per cent. The smear showed moderate variation in size and shape of the red blood cells with many macrocytes. The urine was negative except for a moderate amount of albumin on one occasion. The clinical diagnosis was leukemia, lymphoid in type, aleukemic stage.

Roentgen examination of the skull showed nothing abnormal; the long bones showed a hazy band of decreased density at many of the metaphyseal zones that, while nonspecific, is frequently associated with leukemia. A survey roentgenogram of the abdomen showed each



Fig. 3. Case II. Intravenous urogram fifteen minutes after injection of diodrast demonstrating markedly enlarged kidneys with elongated calices and infundibula without evidence of obstruction, filling defect or deformity.

renal shadow to be prominent with the left displaced downward by a large soft tissue mass apparently the spleen. The chest showed nothing abnormal. Intravenous urogram showed prompt appearance of the dye on the five minute film; each renal shadow was markedly enlarged and the calices and infundibula elongated with no evidence of obstruction, filling defect or deformity (Fig. 3). The roentgen diagnosis was diffuse neoplastic infiltration of each kidney, compatible with leukemic infiltration.

On the nineteenth hospital day a sternal biopsy showed leukemia of the bone marrow which was diffusely cellural with uniformity of cell pattern, the cells being large, with large oval or vesicular nuclei, of the lymphocytic series (Fig. 4).

The patient was treated by transfusions and discharged home three weeks after admission. She died at another hospital five weeks later following two weeks of care there for marked dyspnea, generalized pain and weakness. No autopsy was obtained.

Case III. F.L., a white female, aged eight, who for one year before admission to the Children's Hospital, was noted to be pale, easily fatigued, and to have occasional nosebleeds. She was given iron for her anemia and was said to have improved markedly. Two months before admission, she again became pale, weak, and easily fatigued with frequent nosebleeds, bleeding from the gums and easy bruising. Iron therapy had no effect. Physical examination revealed an extremely pale girl, with one ecchymosis and several petechiae. The heart was moderately enlarged with a soft systolic murmur. There were large hard masses in the upper abdomen on each side, which were first identified as liver and spleen. Examination of the blood showed 24 per cent hemoglobin, 1.53 million red blood cells, 5,950 white blood cells, and 32,000 platelets. The differential count revealed 9 per cent polymorphonuclear leukocytes, 1 per cent myelocytes, 0.5 per cent premyelocytes, 36 per cent small lymphocytes, and 10 per cent were listed as "blast" forms. The reticulocytes were 1.6 per cent. Very few platelets were seen on the smear but the red blood

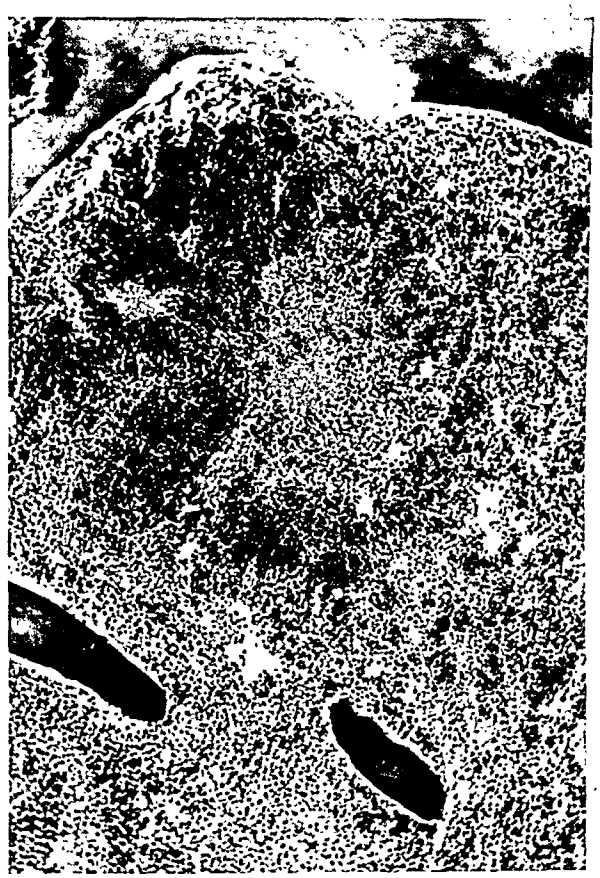


Fig. 4. Case II. Photomicrograph showing leukemia of the bone marrow.

cells in general appeared well filled with hemoglobin and showed moderate variation in size and shape. The bleeding time was greatly prolonged, clotting time was normal, as was the icteric index. Urinalyses showed an occasional small amount of albumin, rare red cells, and an occasional white cell. The serum protein was 6.3 grams, the serum non-protein nitrogen was 37.5 mg. per cent. A stool guaiac test was 2 plus on admission.

On the sixth hospital day, it was noted that, in addition to an enlarged liver, there was a large, round, hard mass in the right kidney region, and the patient was referred to the Department of Roentgenology. Roentgenograms of the skull and long bones revealed no definite abnormality. There was moderate cardiac enlargement, the lungs were clear, and there was no mediastinal lymphadenopathy. A survey roentgenogram of the abdomen showed considerable enlargement of the liver with an enlarged left lobe displacing the stomach to the left; the splenic shadow was not enlarged. Intravenous urogram showed marked enlargement of each renal shadow with considerable enlargement and elongation of the calices and infundibula (Fig. 5).



Fig. 5. Case III. Intravenous urogram on admission. Extreme enlargement of each kidney and elongation of calices and infundibula.



Fig. 6. Case III. Intravenous urogram five days after radiation therapy (350 r) to left kidney. Slight diminution in size is evident.

Repeated blood examinations showed essentially the same picture. The clinical diagnoses considered were acute lymphatic leukemia, thrombocytopenic purpura and polycystic kidneys. It was believed the entire picture could be explained on the basis of leukemia with leukemic infiltration of the liver and both kidneys. Accordingly, it was decided to administer roentgen therapy to the left kidney, shielding the right. During the third and fourth week of the hospital stay, a total of 350 roentgens was given to the left kidney with the following factors: 200 kv., 10 ma., 1.0 mm. Al plus 0.5 mm. Cu filter, 50 cm. distance, half-value layer 1.05 mm. Cu.

An intravenous urogram five days after completion of therapy showed the left kidney and calices to appear slightly smaller, indicating that the renal enlargement was due to radiosensitive tissue (Fig. 6). During the hospital stay the patient was given several transfusions, but continued to have occasional nosebleeds, small petechiae, and on one occasion a right retinal hemorrhage. She was discharged one month after admission with a diagnosis of leukemia, leukopenic, lymphatic.



Fig. 7. Case III. Intravenous urogram five weeks after radiation therapy to left kidney. There is marked decrease in size of left kidney, pelvis and calices.

This child was admitted again three weeks later because of spontaneous epistaxis; blood examination at this time showed 47 per cent hemoglobin, 2.25 million red blood cells, 2,850 white blood cells, with a differential count of 15 per cent polymorphonuclear leukocytes, 70 percent lymphocytes, and 15 per cent "blast" forms. The platelets were 112,000. An intravenous urogram during this admission, five weeks after radiation therapy, showed slight decrease in the size of the right kidney, and a rather marked decrease in the size of the left kidney and calices (Fig. 7).

Following arrest of the epistaxis, several transfusions were given and the patient discharged. She died at home, and a postmortem examination was not done.

The essential feature of leukemia is a neoplastic proliferation of the lymphoblastic or myeloblastic tissues of the body, often with resulting increase in the white blood cells in the peripheral blood stream. There may be proliferation of these white cells in the reticulo-endothelial tissues, but they do not necessarily have to appear in any great numbers in the blood; such a state is called aleukemic leukemia, which is to be considered a phase of the leukemic state. It may be impossible to distinguish sharply between lymphatic leukemia and lymphoblastic lymphoma or lymphosarcoma for a leukemic blood picture may become apparent in the latter conditions at some stage in their course. The appearance of abnormal lymphocytes in the circulating blood (leukemia) may be regarded as an overt manifestation of the underlying disease (lymphoma). In lymphatic leukemia, some myeloid cells may appear in the peripheral blood as a result of bone marrow irritation by lymphoid deposits; a secondary anemia occurs when marrow replacement reaches a severe degree and for a similar reason blood platelets are usually diminished.

Acute leukemia in childhood presents little difficulty when typical clinical and hematologic manifestations are present. Atypical manifestations may obscure the picture to such an extent that the diagnosis becomes more difficult. As a rule, the diagnosis of leukemia is definitely established by blood and bone marrow smears; the marrow reveals the true picture of the disease and by comparing its cells with those of the peripheral blood, the course of the leukemic process can be followed. The acute form of aleukemia is occasionally mistaken for essential thrombocytopenic purpura especially if there is evidence of hemorrhage, anemia, and decreased platelets, a prolonged bleeding time and a normal clotting time. In the latter condition, there is usually a slight to moderate leukocytosis with an increase of polymorphonuclear forms and no abnormal cells in the peripheral blood. Aplastic anemia in children is rare; blood findings similar to those in aleukemic leukemia may be present but reticulocytes are usually absent in aplastic anemia, and the lymphocytes are all mature forms. Sternal or lymph node biopsy should establish the correct diagnosis.

Two of our cases showed an aleukemic

picture and all 3 cases presented a thrombocytopenia, the latter being quite marked in Case III (F. L.) who presented hemorrhages from the mucous membranes into the skin and a retinal hemorrhage. Each child showed a secondary hypochromic anemia, although in 1 case (Case 1) this was not marked until the second admission. Each patient showed a neutropenia and a lymphocytosis, with abnormal white cells in the peripheral blood. There was splenomegaly in 1 case (Case II), hepatomegaly in another (Case III), and mediastinal lymphadenopathy was discovered by roentgen examination in 1 child (Case 1).

According to Minot and Isaacs[10] lesions of the various types of lymphoblastoma are known to develop within the abdomen as a late manifestation of the disease; frequently the abdomen may also be the site of the initial lesion of lymphatic leukemia in its aleukemic form. Abdominal masses were detected in 42 (35 per cent) of 119 patients with initial symptoms referable to lymphoblastoma of the abdomen. Abdominal masses occurring early in the course of the disease may be considered as an indication of a rapid advancement of the disease to the abdomen from other parts; however, lesions due to lymphoblastoma may exist in the abdomen for many months without giving rise to symptoms or signs. After the appearance of symptoms referable to an abdominal lesion, prognosis for long duration of life is poorer than when such manifestations are absent.



Fig. 8. Diffuse leukemic infiltration of the kidneys in situ, from an autopsy of a child three and a half years old. The right kidney weighed 428 grams (normal 89) and the left 462 grams (normal 77).



Fig. 9. Photomicrograph showing diffuse leukemic infiltration of the kidney.

The kidney of diffuse leukemic infiltration is slightly to markedly enlarged, often as much as three to four times normal size, occasionally even larger (Fig. 8). It is soft to firm, rather greasy in consistency, usually with gray or grayish-pink surfaces which frequently show mottled deep brown to red areas of discoloration as a result of hemorrhage. The capsule usually strips easily but may be somewhat adherent as a result of capsular and pericapsular infiltration. The cut surface of the kidney is usually pale gray or pinkish, may show areas of hemorrhage and there may be loss of distinctness of the cortical and medullary structures. Microscopically, the individual nephrons are widely separated by massive cellular infiltration (Fig. 9). The infiltration is most marked in the cortex and usually decreases steadily as the pelvis is approached. There is compression and sepa-

ration of the tubules and there is often a certain degree of tubular degeneration. The glomeruli may be well preserved or show degenerative changes. The leukemic infiltration may be so extensive that relatively few glomeruli and tubules may be seen in any one microscopic field. Areas of extravasation of blood may be seen and there may be infiltrations of the capsule, perinephric fat and pelvis. If there is a full blown leukemic blood picture, the renal blood vessels may be seen stuffed with white blood cells, some of which may even be identifiable as immature cells. The glomerular tufts may be seen to contain an abnormal number of white cells. In the aleukemic state, the contents are usually not remarkable.

The roentgen picture following intravenous urography seems rather characteristic.

In our 3 cases of diffuse leukemic infiltration of the kidney the involvement was bilateral in each instance and there was moderate to marked, symmetrical enlargement of each kidney. The renal pelves were considerably enlarged without dilatation or other evidence of obstruction; the calices and infundibula were elongated without real deformity, filling defects, displacement or irregularity of outline. The appearance of the kidneys visualized roentgenographically is quite readily appreciated when correlated with the gross and microscopic structural changes, the extensive cellular infiltration producing renal enlargement and separation of the parenchymal elements, spreading, separation and elongation of the calices and enlargement of the pelves. Any displacement of the kidneys is due to attendant hepatomegaly or splenomegaly, or retroperitoneal lymphadenopathy, a result of the same leukemic process which can be visualized roentgenographically. Other lymphadenopathy may be present, although often this may be mediastinal and only detected by roentgen examination. The blood picture should show the characteristic findings of leukemia, but in instances in which there is a normal or subnormal white blood cell count a careful examination of the peripheral blood should be made for abnormal cells. Lymph node biopsy or sternal marrow biopsy may frequently be of distinct value in determining the nature of the underlying neoplastic process. Of interest and value is the prompt regression of lymphomatous lesions after relatively small doses of radiation, as demonstrated in one of our cases (Case III).

Mention should be made of the occurrence of renal failure in leukemia as recorded by Merrill and Jackson.[9] It may be due to leukemic lesions with glomerular and tubular degeneration, obstruction of the renal blood vessels or ureters by leukemic tissue, nephrolithiasis or non-leukemic degenerative changes. However, in the 3 patients reported here tubular function as judged by diodrast clearance was excellent.

Roentgenographically, the appearance of diffuse leukemic infiltration of the kidneys is apt to be confused with the picture produced by polycystic kidneys. Diodrast clearance is usually markedly diminished in polycystic kidney and the characteristic multiple rounded filling defects that deform the pelvis, infundibula, and calices should be evident.

Occasionally Wilms' tumor may be bilateral and produce extreme enlargement of the kidneys.[8] We have not seen an embryoma produce the diffuse types of infiltration that is produced by leukemia, although such is a possibility.

SUMMARY

1. Infiltration of the kidneys is frequently found at postmortem in patients dying from leukemia.

2. Occasionally marked enlargement of the kidneys is the presenting sign in a patient with unsuspected leukemia. In such a patient, the diagnosis may be inferred by roentgen examination after the intravenous injection of diodrast.

3. The roentgen appearance seems characteristic but may be confused with that produced by polycystic kidneys.

4. Leukemic infiltration may produce extreme enlargement of the kidneys with marked elongation of the pelvis, infundibula, and calices. Diodrast clearance is well preserved, and there is no evidence of multiple rounded pressure defects.

5. Roentgen irradiation should produce diminution in the size of the infiltrated kidneys.

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LARYNGEAL CHONDRONECROSIS FOLLOWING ROENTGEN THERAPY*

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CHONDRONECROSIS of the larynx after roentgen therapy for laryngeal cancer is precipitated by infection of cartilage with lowered radioresistance. This lowered radioresistance may be due to invasion by cancer or reduced vascularization as, for example, after partial laryngectomy, previous intensive radiotherapy, or preceding disease. Healthy laryngeal cartilage protected by normal mucosa and perichondrium will withstand the infection which is always present in the larynx and will usually tolerate modern fractionated therapeutic roentgen-ray dosage. According to Gates[4] "adult cartilage stands large amounts of radiation without marked gross change so long as it is protected. When it is infected or traumatized, extensive necrosis and sequestration may occur." Chondronecrosis is exceptional in superficially fungating early and small carcinomas. It is commoner in more advanced and extensive growths, especially if they have a tendency to invade the subjacent tissues and thus obstruct the flow through the venous and lymphatic capillaries, causing edema of the mucosa. The edematous mucosa tends to ulcerate superficially affording access for bacteria to deeper tissues. The infection spreads to the perichondrium. The resulting perichondritis interferes with the nourishment of the cartilage and chondronecrosis ensues. A similar train of events, however, may occur without roentgen therapy, solely as result of progressive infiltration of the cartilage by cancer.

Following radiation treatment it is often impossible, clinically, to differentiate between chondronecrosis due to infiltration by cancer and one due only to the radiotherapy. Probable absence of cancer may be assumed if a sufficiently long period of clinical freedom from cancer has elapsed between the chondronecrosis and the follow-up examination. The roentgen-ray reaction during and after the course of fractionated roentgen therapy is similar in patients developing chondronecrosis and successfully treated patients. Slight edema of the laryngeal mucosa, especially over the arytenoids, is often seen during the course of roentgen therapy for cancer of the larynx. This edema becomes more pronounced after one-half to two-thirds of the dosage has been given, again at the conclusion of therapy and usually subsides within four to six weeks after the radiation treatment. In patients who develop perichondritis and chondronecrosis, the edema may persist or recur soon after conclusion of the reaction. In time the edema becomes more pronounced. The laryngeal structures become extremely swollen and distorted. Narrowing of the airway frequently makes tracheotomy necessary. With the onset of frank chondronecrosis, the breath becomes foul. Pieces of sequestrated cartilage as, for example, in chondronecrosis of the epiglottis may fall into the ventricle and be expectorated; they may accumulate in a depression as, for example, in chondronecrosis of the arytenoids, or be aspirated. Aspiration pneumonia or lung abscess may follow. The patient may die either of pulmonary complications, sepsis, or gradually increasing cachexia due to absorption from the necrotic area.

Microscopically, heavily irradiated carti-

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lages are likely to be devoid of osteoblasts and osteoclasts, whereas non-irradiated cartilage does not show these changes. In determining whether or not there is persisting cancer, even microscopic examination may be inconclusive, unless the entire larynx is available for study, as for instance after laryngectomy or at postmortem examination. If a single biopsy is done, it is not uncommon to find that the cancer has been missed entirely, or that only a piece of necrotic material has been obtained, from which a definite diagnosis cannot be made.

We have not seen any definite indication that biopsy has precipitated chondronecrosis in ulcerated cancers of the larynx. In a non-ulcerated, heavily irradiated mucosa, however, biopsy might open channels for the entrance of infection and thus lead to chondronecrosis. Because of this, post-irradiation biopsies in this type should not be undertaken lightly.

CLINICAL MATERIAL

Laryngeal chondronecrosis following roentgen therapy for cancer of the larynx occurred in 28 of 205 cases treated at the Presbyterian Hospital, New York, between 1932 and 1946. Patients with gross clinical evidence of persisting cancer were not included in this study.

Eight cases of chondronecrosis were apparently free from carcinoma. In 4 postmortem examinations, and in 2 laryngectomy specimens, microscopic study of the larynx failed to reveal persisting cancer. The interval between the last roentgen treatment and microscopic examination in the 4 dead patients was four to nine months and in the laryngectomy cases five and eighteen months. The 2 remaining patients have been free from clinical evidence of cancer eight and fifteen years, respectively, after treatment. It may be assumed, therefore, that in these cases the cancer had been destroyed before the occurrence of chondronecrosis or that it was completely carried away with the slough.

Two patients showed persisting cancer on biopsy of the larynx. It is not known whether cancer persisted in the remaining 18 cases.

The occurrence of chondronecrosis seemed to be influenced by the following factors: the interval between the last roentgen treatment and occurrence of chondronecrosis, the site and extensiveness of the cancer prior to the chondronecrosis, partial laryngectomy prior to irradiation and the technique of treatment.

Interval between Roentgen Therapy and Chondronecrosis. Chondronecrosis usually developed within six months from the time treatment was finished, as seen in Table 1.

Table I

Interval	Number Cases of Chondronecrosis
Within 6 months after the last roentgen treatment	23
Six months to a year after the last roentgen treatment	2
Over one year after the last roentgen treatment	3

Site of Chondronecrosis. The site of the chondronecrosis was known to be limited in 2 patients to the epiglottis; in another to the thyroid cartilage. The remainder, however, showed such extensive necrosis when first seen that it was difficult to ascertain its point of origin.

Of the 28 cases, 17 showed preceding fixation of the arytenoid, suggesting that this may have been a frequent initial site of the chondronecrosis in this series.

Hautant, who followed 200 carcinomas of the larynx treated by Coutard, stated in 1927 that the lower angle of the anterior borders of the thyroid cartilages was in his experience the most common site of radionecrosis. The anterior borders of the thyroid cartilages which are joined at an acute angle form the narrowest portion of the larynx; thus they are exposed to the largest roentgen-ray dosage when the larynx

is cross-fired from each side. Chondronecrosis of the thyroid cartilage did not appear to be the most frequent site in the present series of cases.

Chondronecrosis occurred in a higher proportion of cases of cancer of the epiglottis than in cancer arising in any other site in the larynx. Most cured cancers of the epiglottis show a deformity of the cartilage indicative of a healed area of chondronecrosis. If small, such deformity is usually not recognized. In the present series 25 carcinomas of the epiglottis have been treated since 1932; 6 of these developed marked chondronecrosis. The epiglottis lies directly beneath the mucosa and is invaded early in the course of the disease. Gross necrosis occurred in only 1 case in which the disease was limited to the free portion. This occurred eight years after treatment.

Extensiveness of Cancer and Chondronecrosis. The extensiveness of the cancer had a definite influence on the occurrence of chondronecrosis, as seen from Table II. There was only 1 case in which the disease was of limited extent—on the free portion of the epiglottis.

TABLE II

Site of Cancer	Number Cases of Necrosis
Confined to vocal cord	0
Vocal cord* with extension	16
Confined to epiglottis (free portion)	1
Epiglottis with extensions	5
Extensive cancer—primary unknown	6
	28

* Arytenoid fixed—11.

Partial Removal of Thyroid Cartilage and Chondronecrosis. Roentgen therapy after laryngofissure was done in 7 patients. Two of the 7 cases developed chondronecrosis.

One hemilaryngectomy was done two weeks after a tumor dose of 7,800 roentgens. The removed portion of the larynx showed only radiation reaction without evidence of necrosis or persisting carcinoma. After the operation chondronecrosis developed promptly in the remaining portion of the larynx. Another patient had partial bilateral removal of the thyroid cartilage before roentgen therapy and developed chondronecrosis of the remainder of the cartilage. Partial resection of the thyroid cartilages associated with operations on the intrinsic larynx prior to roentgen therapy has, in our experience, increased the likelihood of chondronecrosis developing in the remaining cartilages. The scarring and impairment of the blood supply in our cases has appeared to reduce the tolerance of the larynx to roentgen therapy and to infection.

In contrast to our experience, Arbuckle reported 18 cases of advanced laryngeal cancer in which he subperichondrially resected the thyroid cartilages before roentgen therapy. Of these cases, 7 were living without evidence of local cancer one to eight years after treatment. His operation varies from any of our operated cases in that *the cartilage alone is removed, the perichondrium is left intact* and the laryngeal cavity is not entered, avoiding contamination of the operative field. When this precaution is not observed the tendency to chondronecrosis seems to be increased by partial removal of the thyroid cartilage. Arbuckle further states that the laryngeal function is not impaired because of the firm fibrous structure which replaces the removed cartilage. Roentgen therapy in his cases was started two weeks postoperatively.

Technique of Treatment and Chondronecrosis. The technique of roentgen therapy in the cases of chondronecrosis on the whole did not differ from that used in cases which did not develop this complication. One gained the impression, however, that the larger the fields and daily dose and the shorter the period of treatment, the more frequently did laryngeal edema appear after the therapy. Marked laryngeal edema in its turn at times was a precursor of chondronecrosis. In this connection it might be recalled that in the early days of

200 kv. roentgen therapy of cancer of the larynx, extensive radiation fields and large fractions of the total dose or even single massive treatments were given. For instance, Jüngling warned against roentgen therapy of operable cancer because of the danger of roentgen-ray damage to the larynx. However, he administered about 1,000 r each to a right and left lateral laryngeal field at a single exposure and repeated this intensive treatment once or twice at monthly intervals. In our early cases daily doses of 400 r to one field were not uncommon. All surface doses in this article are stated as "dosage in air" unless otherwise specified.

Of the 28 patients who developed chondronecrosis, 14 received a tumor dose of 5,500 to 6,000 r. Ten cases were given tumor doses of 6,000 to 7,000 r. In passing, it is interesting to note that the tumor doses in 21 patients with cancer of the larynx, similarly treated and now free from clinical evidence of cancer for five years, varied from 5,500 to over 8,000 r.

The treatment time in the cases with chondronecrosis varied from seventeen to fifty-one days, the majority being treated in from thirty to forty-five days. The latter is the period now usually employed for the treatment of most cases of carcinoma of the larynx at the Presbyterian Hospital.

The daily dosage was usually 100 to 150 r to each of two opposing lateral laryngeal fields, but was 400 r to one field in nearly one-third of the cases. In a few cases in which marked edema was present prior to the treatment, the initial dosages were as low as 50 r. The size of the radiation fields were usually 6 by 8 or 8 by 10 cm. and varied in a few cases from 4 by 5 to 10 by 15 cm. These technical factors did not differ materially from those used in patients receiving roentgen therapy for laryngeal cancer, who did not develop chondronecrosis.

The doses in most cancers of the larynx receiving roentgen therapy at the Presbyterian Hospital vary between 6,000 and 7,000 r in air in six weeks. The two lateral fields, one on either side of the larynx, are directed somewhat obliquely toward the larynx, with a strip of unirradiated skin 1 cm. or less in width left in the center anteriorly, except in anterior commissure lesions in which the fields may overlap. Two hundred kilovolts, 2 mm. of copper or Thoraeus filter and 50 cm. target-skin distance are used, and a daily dose of 100 r to each of the two lateral fields is administered. The size of the fields vary from 4 by 5 to 8 by 10 cm., 6 by 8 cm. being the most common. If cervical nodes are present they may be treated over separate fields. The center of the larynx is estimated as being approximately 3 cm. from the center of each treatment field and tumor doses are thought to be almost equal to the sum of the air doses administered to each side except if the fields are smaller than 6 by 8 cm.

The reactions during treatment vary moderately with different individuals. Treatment is interrupted after 1,400–1,800 r in air to each of the two fields, if a pseudodiphtheritic membrane develops on the irradiated mucosa, and is resumed after a few days, when the membrane begins to subside. If the initial membrane does not develop until after 2,500 r has been given to each field, treatment if possible is not discontinued but is carried to completion, i.e., a minimum of 3,000 r to each field. The treatment may occasionally be interrupted after one-half to two-thirds of the total dose has been administered to allow the radiation edema to subside. In those cases in which the extent of the disease and associated edema cause an inadequate airway, tracheotomy may be done before treatment. In these cases, treatment may be given more slowly at first, i.e., 50 to 75 r in air daily to each field, up to a total of 400 to 500 r in air. At this time the local inflammatory reaction will often have subsided and the danger of obstructing the airway will have been reduced.

If treatment is successful, the membrane clears, the edema subsides and all local evidence of the carcinoma disappears. Some edema of the arytenoids may persist. This

is especially common if more than 1,000 r has been given with fields 8 by 10 cm. or larger. This late edema occurs chiefly in extensive cases and may persist for a number of months even in cured patients. It may be subject to moderate episodes of increased severity, secondary to upper respiratory infections or injudicious use of the voice or tobacco. Fixation of the arytenoids may be permanent even in cured cases. Though absence of gross evidence of disease usually means arrest of the cancer, it does not necessarily guarantee a cure, as microscopically persisting carcinoma may become clinically appreciable within a few weeks, months or years after treatment.

PROGNOSIS

The extent, the location and the time of onset of the chondronecrosis influence the outlook for healing.

Chondronecrosis of the free portion of the epiglottis has a much more favorable prognosis than necrosis of other laryngeal cartilages. Virtually every case of cancer of the epiglottis arrested by roentgen therapy has a residual deformity following treatment, which implies previous destruction of the affected part of the cartilage. This takes place in the successful case without ensuing necrosis of the remainder of the cartilage. The downward drainage from the epiglottis allows sequestra to slough out into the ventricle whence they are promptly coughed up. Extension of the necrosis to the base of the epiglottis or to the pre-epiglottic space is much more grave and recovery here is rare.

Chondronecrosis in the region of the arytenoid cartilage also has a bad prognosis. Here, the necrotic ulcer forms a depression from which it is difficult to dislodge sloughs and sequestra as drainage is upward and as this cavity cannot be emptied by coughing. Absorption from this necrotic area, cachexia, aspiration pneumonia and lung abscess may result. We have seen only a few chondronecroses of the thyroid cartilages, all in extensive carcinomas and all these cases dead.

The time of onset of chondronecrosis in the present series seemed to be of prognostic importance. This is contrary to the experience of Van Rosen who reported recovery in 9 of 23 cases of perichondritis and chondronecrosis of the larynx following irradiation. In 5 of these 9 cases symptoms suggesting perichondritis appeared in less than one year and in 4 more than one year after treatment.

In the present series of cases in those developing chondronecrosis early, there was greater likelihood of persisting carcinoma. The extent of necrosis of the soft tissues was generally greater and healing either after sloughing of the necrotic cartilage or after its surgical removal was not as good as in the "late" cases, which seemed to progress more slowly and not so far.

Of the 28 cases of laryngeal chondronecrosis 23 developed within six months, 2 within one year and 3 over a year after the last roentgen treatment. The 3 patients developing chondronecrosis more than one year after treatment recovered: 1 after laryngectomy, 1 after removal of the necrotic portion of the epiglottis, and the third after sloughing of the necrotic cartilages.

PREVENTION AND TREATMENT OF LARYNGEAL CHONDRONECROSIS

In the preceding paragraphs it has been shown that laryngeal chondronecrosis after roentgen therapy occurs chiefly in cartilage with lowered radioresistance and is precipitated by the entrance of bacteria into this cartilage. In such cases, therefore, it would seem logical to substitute surgery for roentgen therapy, where practical, and also to try to reduce infection prior to irradiation, if the use of roentgen therapy cannot be avoided. It will be remembered that chondronecrosis was more common in extensive, infiltrating cancers, occurred more readily after partial laryngectomy and though most common in the epiglottis was serious chiefly when involving the base of this cartilage, the arytenoids or thyroid cartilages. We believe that impending chondronecrosis may in rare instances be aborted by the use of sulfonamides and penicillin,

but once established it is influenced much less. In several extensive carcinomas of the larynx with marked infection prior to roentgen therapy and marked edema after treatment, we believe we prevented the full development of chondronecrosis by the use of 250,000 units of oral penicillin daily for a week or two, and saw the gradual regression of the edema and return to a more normal looking larynx.

While the total removal of the cartilage by laryngectomy makes chondronecrosis impossible, the subperichondral removal of the cartilage, as proposed by Hautant and recently by Arbuckle, may also offer hope of avoiding this complication.

As far as the *technique of roentgen therapy* is concerned, it is our impression that doses of roentgen rays much larger than 100 r, in air, daily to each of two lateral 6 by 8 cm. fields with the usual 200 kv., 50 cm. target-skin distance, 0.5 mm. Cu filter, are preferably not carried further than 500 r or at most 1,000 r to each field, for fear of causing later edema of the larynx and thus perhaps favoring radionecrosis. With smaller fields slightly larger daily doses may be given. In discussing this point with some advocates of much higher daily dosage and shorter over-all treatment period, we have gained the impression that the survival rate from this more rapid method is no better, and the likelihood of edema and chondronecrosis greater, than when the daily doses are less and the treatment period five to seven weeks. The use of unnecessarily large fields should be avoided if smaller fields will include the entire cancer. Irradiation of large volumes of normal tissue increases the likelihood of edema, chondronecrosis and later irradiation sequelae. In extensive cancers large fields cannot be avoided and the over-all period might be increased in order to prevent severe radiation reaction. Tracheotomy when indicated should be made below the irradiated area, as otherwise this may precipitate chondronecrosis by permitting the entrance of bacteria into irradiated and damaged cartilage.

Local resection of the necrotic portion of an epiglottis was done in 1 patient who recovered.

Laryngectomy for removal of the chondronecrotic larynx has been performed in 3 of our 28 cases. Each had received a tumor dose of 6,000 r in six to eight weeks. Tumor persisted locally in the first case and could not be found in the second and third cases. The first patient was a male, aged fifty-four, with a cancer of the true cord, for which an unsuccessful laryngofissure and cordectomy had been done three years, and an unsuccessful hemilaryngectomy one year, before roentgen therapy. Because of persisting tumor, complete laryngectomy was performed five months after the end of roentgen therapy. Advanced necrosis was present at operation. The wound sloughed, and the patient died eight days after laryngectomy. The second patient was a male, aged sixty-eight, with an undifferentiated carcinoma of the left ventricular band, interarytenoid space and cord. Persisting edema of the arytenoids followed treatment. Eighteen months after treatment chondronecrosis was considered probable and a laryngectomy was done. The patient recovered, although there developed a hypopharyngeal fistula, necessitating plastic repair. The specimen showed chondronecrosis of the epiglottis, destruction of the left true cord extending into the submucosa, but not to the cartilages. The third patient was a male, aged sixty-nine, with a carcinoma of the left true cord and extension into the false cord and ventricle. Some edema of the laryngeal mucosa occurred during treatment and persisted following roentgen therapy. Four months after treatment a foul odor suggested chondronecrosis and two months later a laryngectomy was done. The operated specimen showed only necrosis without any evidence of cancer. A hypopharyngeal fistula developed necessitating plastic repair. The patient recovered from the laryngectomy but a few months later showed evidence of cancer at the base of the tongue beyond the operative site.

Three patients, not included among the cases of chondronecrosis had *successful*

laryngectomies after full courses of roentgen therapy for cancer of the larynx. In one, with a post-irradiation ulcer of the larynx, two biopsies were negative for cancer while the two others had laryngectomies for persistent cancer, one and five months after roentgen therapy. Both of these patients recovered from the laryngectomy without appreciable delay in healing or other sequelae. These 3 cases and similar experience of others show that healing of the laryngectomy wound may be unimpaired in spite of preceding unsuccessful roentgen therapy for cancer of the larynx.

SUMMARY

1. Twenty-eight cases of chondronecrosis of the larynx following roentgen therapy have been reviewed.

2. Eight of the twenty-eight have been found to be free of cancer. In most of the others it was not possible to determine whether cancer persisted microscopically or whether one was dealing only with radionecrosis.

3. Of the twenty-eight cases, twenty-three appeared within six months, two within one year, three more than one year after treatment; the latter three recovered, one after sloughing, one after local removal of the necrotic portion of the epiglottis and one after laryngectomy.

4. Laryngeal chondronecrosis occurred chiefly in advanced and extensive carcinomas and exceptionally in those which were early and small.

5. a. Chondroncerosis involved the epiglottis more frequently than other laryngeal cartilages. When developing in its free portion prognosis was good, as nearly every cured case of epiglottic carcinoma showed a deformity of the healed radionecrotic area. Prognosis was poor when necrosis extended to the base of the epiglottis or the pre-epiglottic space.

b. The outlook was also poor when the arytenoids or thyroid cartilages were involved.

6. Laryngofissure or partial laryngectomy either before or after a full course of roentgen therapy seemed to favor the development of chondronecrosis in the remaining cartilage. The exception to this was the removal of the necrotic free portion of the epiglottis. Total removal of cartilage by laryngectomy avoided this complication.

7. The use of penicillin and sulfonamides seemed to help to abort the threat of chondronecrosis, but was less effective when chondronecrosis had fully developed.

8. Laryngectomy should be considered in selected cases with early or impending chondronecrosis.

9. Variations in fractionated roentgen dosage as given at the Presbyterian Hospital did not appear to influence the development of chondronecrosis.*

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* For discussion see page 36.

ROENTGEN TREATMENT FOR EXTENSIVE EPITHELIOMA OF THE LARYNX

RESULTS IN 139 CASES*

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GENERAL CONSIDERATIONS

WHEN a patient is afflicted with epithelioma of the larynx, his chance of being cured rests on early diagnosis and early treatment. The earlier the malignant condition can be recognized, the better the prognosis, provided the tumor is completely removed or destroyed before it has become too extensive and before malignant cells have invaded the tributary lymph nodes. When the malignant process is not recognized until it has invaded neighboring structures, tissues or lymph nodes more or less extensively, the chance of curing the patient by any method of treatment diminishes rapidly in proportion to the extent of involvement. Another important factor is the grade of malignancy of the neoplastic process; the greater the degree of malignancy, the more rapidly the tumor tends to grow and to invade adjacent tissues.

Among the malignant tumors which affect the larynx, epitheliomas or carcinomas are by far the most common. These tumors are much more common in men than in women. When the neoplastic condition can be eradicated surgically, a large percentage of patients can be cured. Surgical eradication may consist of oral removal from the epiglottis and adjacent supraglottic portions of the larynx by surgical diathermy after preliminary tracheotomy, of thyrotomy and surgical diathermy for epithelioma of the larynx involving the anterior two-thirds of the vocal cords, of laryngectomy for fixed growths with infiltration of muscle, of block dissection of involved cervical nodes when the neoplasm has a low grade of malignancy, or of roentgen treatment to the cervical nodes when the tumor has a high grade of malignancy.

Of 446 patients on whom operation had been performed at the Mayo Clinic from 1934 through 1943, New and others[3] reported that 213 (47.7 per cent) had undergone laryngectomy; 184 (41.2 per cent) had undergone thyrotomy, and 49 (11.1 per cent) had undergone laryngeal suspension, destruction of the growth by surgical diathermy, and implantation of radon seeds. Of these 446 patients, 90.4 per cent were male and 9.6 per cent were female; 80.9 per cent were from forty-five through sixty-nine years of age, 12.6 per cent were less than forty-five years of age, and 6.5 per cent were older than sixty-nine years.

Of the patients who had undergone laryngectomy and whom New had been able to trace, 60.2 per cent lived five or more years after the operation. In these cases 46 per cent of the neoplasms were epitheliomas of Grade 1 or 2 (Broders' method, and 54 per cent were epitheliomas of Grade 3 or 4. Of the patients who had undergone thyrotomy 83.6 per cent lived five or more years after operation. In 61 per cent of these cases the tumors were epitheliomas of

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Grade 1 or 2, and in 39 per cent they were epitheliomas of Grade 3 or 4. As for the patients who had undergone suspension laryngoscopy, with diathermic destruction of the growth or implantation of radon seeds, 91.7 per cent lived five years or longer after operation, and 82 per cent of these had epitheliomas of Grade 1 or 2. Apparently, the larger percentage of cases in which the neoplasms had a relatively low grade of malignancy had much to do with the high rate of survival. Of this entire series of patients 73.5 per cent lived five years or longer after operation.

When the malignant process was extensive, when cervical lymph nodes were invaded, and when, for these reasons or because the patient's general condition was not good, surgical treatment did not seem advisable or could not be employed, the patients were treated with roentgen rays, often after preliminary tracheotomy.

At one time, years ago, when a patient had an epithelioma of the larynx which was too extensive to be removed or destroyed surgically, the patient's fate was well-nigh sealed, and the prognosis was gloomy indeed. This is no longer true to anything like the same degree. At the present time even rather extensive neoplasms can sometimes be treated effectively; in a certain percentage of cases the malignant process can be made to disappear, and some patients are fortunate enough to remain well. This difference has been brought about by improvements in the technique of roentgen or radium treatment.

The experiments of Regaud[4,5] had shown that, when the testis was exposed, at one time, to a single dose of radium, partial or complete sterilization of the organ ensued, according to the dose of rays; but when the testis was exposed to a small dose of radium and when this was allowed to act steadily for some time, sterilization of the testis was obtained with a much smaller total dose than when the testis was exposed to a single dose at one sitting. Other experiments, which had been carried out by Wood and Prime,[6] had shown that, in order to arrest the growth of an epithelial neoplasm completely, a total dose of roentgen rays equivalent to between three and five times an erythema dose is required.

Coutard[1,2] undertook to apply these principles to the treatment of epitheliomas of the larynx, pharynx and mouth, and the results which he obtained were far superior to those which had been obtained previously. Since then, the method of fractional roentgen irradiation (often called the Coutard method) for epithelial neoplasms has been widely adopted. It is pertinent to mention, however, that the superior results obtained by Coutard and many others, by means of fractional irradiation with large total doses, concerned only carefully selected cases. Some radiologists and certain radiologic institutes have chosen for treatment only cases which were considered favorable; other cases in which the malignant neoplasms were extensive and which, for this reason, were not deemed favorable, were discarded as unsuitable for roentgen or radium treatment.

CASES AND METHOD OF TREATMENT

The purpose of this paper is to review and analyze a series of 139 cases in which epithelioma of the larynx has been treated with fractional doses of roentgen rays from 1936 through 1945. All the patients had extensive epithelioma—in most cases the neoplasms were so extensive that surgical treatment was not considered advisable. Other patients, who had undergone previous laryngectomy here or elsewhere, were suffering from more or less extensive recurrence; and in a large percentage of cases the malignant process had invaded some of the cervical nodes. In many cases respiratory obstruction required preliminary tracheotomy.

Tracheotomy. Among all the patients included in the series of 139 cases tracheotomy was not performed at any time in 56 cases; tracheotomy was performed before roentgen treatment in 76 cases; during the course of roentgen treatment in only 1

case, and soon after the course of treatment in 6 cases.

From the foregoing circumstances it is evident that the cases included in this group could hardly be regarded as favorable; indeed, a more unfavorable group of cases would be difficult to find.

Technique of Treatment. All these patients were treated with rays generated at 200 peak kilovolts, filtered through a Thoraeus filter consisting of 0.44 mm. of tin, 0.25 mm. of copper and 1.0 mm. of aluminum, at a focal-skin distance of 50 cm. The half-layer value was equivalent to 1.75 mm. of copper. In most cases the treatment was given through two lateral fields (one on each side), each of which measured from 8 by 12 cm. to 12 by 18 cm.; but in a small number of cases the treatment was given through three fields (two on one side and one on the other); when two fields on one side were employed, they were on the side on which the bulk of the malignant process was situated.

During the early part of this period, the roentgen treatment was arranged in different ways in an attempt to find the time distribution, the daily dose, and the total dose which would yield the most favorable results. Most of the patients were treated twice a day for periods varying between fifteen and thirty days, but a certain number were treated once a day for a similar period. Except on Sunday, all patients were treated as much as possible on consecutive days; but sometimes, because of radiation sickness or for some other reason, the course of treatment was interrupted, at or near the middle, for one, two, or three days. Six patients were treated for sixteen days, 1 for seventeen days, 1 for eighteen days, 30 for twenty days, 1 for twenty-one days, 2 for twenty-two days, 12 for twenty-three days, 5 for twenty-four days, 65 for twenty-five days, 2 for twenty-six days, 1 for twenty-seven days, and 7 for thirty days.

In 6 cases treatment was discontinued: after ten days in 1 case, after thirteen days in 3 cases, after fifteen days in 1 case, and after sixteen days in 1 case. This had to be done because the patients' condition had become too bad to continue treatment (5 cases) or because the patient refused to carry on (1 case).

The total dose given to each field varied from 2,000 to 4,000 roentgens, measured in air; in most cases the total dose was greater than 3,000 roentgens. Therefore, when the treatment was given through two fields, the total dose for both fields varied between 4,000 and 8,000 roentgens; and when the treatment was given through three fields, the total dose varied between 6,000 and 10,000 roentgens. In normal persons the width, or lateral thickness, of the neck varies between 10 and 16 cm.; but, since most of the patients who were referred for treatment had lost weight, the lateral thickness of their necks varied between 10 and 14 cm. The thickness of the average patient's neck, therefore, is approximately 12 cm. Half this thickness would be 6 cm. With roentgen rays generated at 200 kilovolts and filtered through a Thoraeus filter composed of 0.44 mm. of tin, 0.25 mm. of copper and 1.0 mm. of aluminum, approximately 70 per cent of the air dose would be delivered 6 cm. beneath the skin. Therefore, if an air dose of 3,800 roentgens is given through each of two fields, the total dose reaching the tumor in the middle of the neck would be approximately 5,320 roentgens.

Gradually it was found that there is such a thing as too large a total dose, which causes severe reaction of the mucous membranes and skin without improving the end result. In time it was learned that a total dose between 3,500 and 4,000 roentgens to each of two fields yielded as good results as could be obtained; in the average case such a total dose to each field caused a reaction of the mucous membrane and of the skin which was not unduly severe (moderate epithelitis and epidermitis). In some cases the reaction was only slight, but in a small percentage of cases even this dose caused a rather severe reaction.

The reason why many patients were

treated twice a day was the hypothetical reason of trying to irradiate as many cells as possible during the active phase of mitosis. In all probability it would be impossible to recognize clinically any difference in the biologic effect of irradiating a neoplasm once a day or twice a day, but some hypotheses are so appealing! Another subsidiary reason for irradiating the epitheliomas twice a day was that this might cause less systemic reaction (radiation sickness) than exposure to the same daily dose at one sitting. It is now clear that any difference in this respect is too slight to be perceptible clinically.

Coutard[1,2] and many other radiologists have given total doses of approximately the same magnitude or even larger doses, and they have spread the treatment over a period varying from fourteen to twenty-five or thirty days, and in some cases as long as sixty days. Most patients can tolerate from 200 to 400 roentgens a day without undue disturbance, many can take 300 or 400 roentgens daily without any sign of intolerance, but in some cases even 200 roentgens a day causes the patient to lose appetite or to vomit. In our experience a daily dose between 300 and 325 roentgens is tolerated by most patients, but sometimes the daily dose must be reduced to 250 roentgens or even to 200 roentgens. In some cases, for this reason, the period of treatment has extended over twenty-five days. It is possible that to have shortened the period of treatment to twenty days, or even less, might have improved the results; but this would have required the patients to take a daily dose of nearly 400 roentgens, and almost certainly many patients would have found it difficult or impossible to tolerate this larger daily dose. Even with a daily dose of about 300 roentgens, many patients have lost weight, and sometimes this loss has been considerable.

During recent years some radiologists have advocated treatment through small fields; or, after starting treatment through fields of a certain size, some have recommended reducing the size of the fields as the neoplasms retrogress. No doubt these methods can be used effectively in selected cases, when the neoplasms are not extensive; but in most of the cases with which we have had to deal too small fields would almost certainly have meant that some parts of the malignant process would not have been included or would not have received an adequate dose. In cases of this kind, therefore, the method of diminishing fields would be dangerous. Our attitude has been that, unless the entire neoplasm is treated, the patient might as well not be treated at all. To us, even at the cost of more extensive and more severe reaction, it has seemed preferable—indeed essential—to irradiate through rather large fields in order to avoid the risk of missing part of the malignant process. Even with large fields, we are certain that, in some cases, outlying extensions or infiltrating portions of the neoplasms, or involved lymph nodes, did not receive adequate exposure or were missed altogether.

Tolerance and Reaction. During the first half of the course of treatment, most patients can eat about as usual, and their weight does not diminish much, if at all. But a small percentage of the patients do not tolerate the treatment well, nausea causes their appetite to diminish, and they lose some weight. Sometimes it is necessary, on account of a low tolerance, to interrupt the treatment for two or more days in order to allow the patients to recuperate enough to enable them to complete the course of treatment. In some cases in which the patients have some degree of obstruction and dysphagia it is necessary, for this reason, to insert a tube through the nose into the stomach, and the patients are fed artificially. This seldom occurs during the first half of the course of treatment. When, between the twelfth and fourteenth days, the mucous membrane begins to react (epithelitis), most patients have an increasing difficulty in eating enough food to nourish themselves adequately. Usually this is because the gradually increasing reaction of the mucous membranes causes swallowing to become more and more painful; but sometimes, in cases in which,

before treatment, some degree of obstruction was present, the mucosal reaction causes the obstruction to become complete, or nearly so. It is especially in cases of this kind, and at this stage, that the insertion of a tube for artificial feeding may become an urgent measure. Some patients may lose from 5 to 15 pounds (2.3 to 6.8 kg.), or even more.

After the entire course of treatment has been completed, the epithelitis and epidermitis continue for two or three weeks, slowly subsiding during this period. By this time the neoplasm has retrogressed more or less; and at the same time the patients have less difficulty in swallowing and, as they can take more food, their weight begins to increase. Usually the weight which had been lost before and during the course of treatment, or at least much of this lost weight, is regained within two or three months after completion of the treatment. When, three months after treatment, most of the patients returned for reexamination, most of them had recovered the weight which had previously been lost, their general condition had greatly improved, and the tumor had disappeared. In some cases, however, residual edema made it difficult or impossible to be certain whether or not the malignant process had completely disappeared; and when cervical lymph nodes had been affected more or less extensively, the involved nodes usually had diminished and often they also had disappeared. Sometimes, when lymph nodes in the lower part of the neck had been involved, they did not retrogress as much as nodes high in the neck. In some cases, also, affected nodes in the upper part of the neck underwent only partial regression during the first three months, but complete regression of these nodes occurred later. This, however, was not always true. In most cases, when the involved cervical nodes had not disappeared at the end of three months, complete regression did not occur at any time, and subsequently the malignant process in these nodes again became active.

As has already been shown, the most favorable cases are usually selected for surgical treatment, and only the cases which surgeons consider unsuitable for surgical treatment are referred for roentgen treatment. Some of the patients in this series had undergone operation one or more times, and some had undergone laryngectomy. Others had undergone electrocoagulation, with or without implantation of radon seeds. These were referred for roentgen treatment because further surgical measures were out of the question. Under these most unfavorable circumstances, to expect to cure many patients would be sheer folly, and yet, as will be seen, some patients were cured, and many others derived substantial improvement which continued long enough to be well worth the effort to treat them.

The number of cases included in the series which we are reporting is 139. Among these, 120 of the patients were male and 19 were female. This overwhelming preponderance of male patients agrees with the experience of all those who have written about epithelioma of the larynx. Among these patients 81 were from forty through sixty years of age; of those less than forty years were 1 patient aged thirty-four years, 4 patients aged thirty-five years, and 1 patient aged thirty-eight years. Among those who were older than sixty years, 17 patients fell in the age group from sixty-one through sixty-five years; 14 fell in the age group from sixty-six through seventy years; 13 fell in the age group from seventy-one through seventy-five years; 6 fell in the age group from seventy-six through eighty years; the age of 1 patient was eighty-one years, and that of the oldest patient was eighty-two years. Thus, 52 patients were aged from sixty-one through eighty-two years. Of the total number of patients in this series, the proportion of those whose ages were seventy-one years or more was 15 percent.

Regression of Tumors and of Involved Lymph Nodes. In a large percentage of the cases a course of treatment such as has been described was accompanied by rapid regression of the neoplastic process; by the time the course of treatment had been completed, the tumor had retrogressed so much

that it could no longer be recognized. In other cases the treatment was accompanied by substantial regression, but some of the tumor or secondarily involved lymph nodes could still be seen or felt at the time the course was completed. In many of these cases apparently complete regression required about two months after the end of the course of treatment. By this is meant that, about two months after the course of treatment had been completed, clinical or laryngoscopic evidence of the neoplasm could no longer be found. Three months after treatment, in most cases, some degree of residual edema in the larynx and in the soft tissues of the neck was present in a large percentage of cases. This edema slowly diminished, and usually, but not always, it had disappeared at the end of six or eight months. In a small percentage of cases some edema continued still longer.

As far as the patients' symptoms were concerned, these usually subsided in proportion to the degree of regression of the neoplasm and at approximately the same rate. An interesting point, however, is that even when the malignant process had disappeared, many patients did not recover the normal quality of their voice. Other symptoms, such as hoarseness, cough, dyspnea, or dysphagia, often disappeared or greatly diminished, but many patients were left with a voice which was not entirely normal. Sometimes this was due to the scarring of previously involved larygneal structures after regression of the neoplasm; sometimes, no doubt, it was due to incomplete regression of the malignant process, even when this could no longer be seen; and sometimes it was due to residual edema.

Of the 139 cases a piece of tissue or a lymph node had been removed for biopsy in 126 cases (90.6 per cent). In the remaining 13 cases tissue for biopsy had not been removed, but in all of these the clinical features were such that the malignancy of the lesion could hardly be doubted. Of the 126 cases in which the diagnosis had been confirmed by microscopic examination of sections of tissue not one had a neoplasm with a malignancy of Grade 1 (Broders' method); from this it is apparent that all patients who had tumors with Grade 1 of malignancy were treated surgically. In 41 cases the neoplasms were of Grade 2 malignancy, in 55 cases the tumors were of Grade 3, and in 28 cases they were of Grade 4 malignancy. In 1 case the pathologist who examined sections of tissue from the tumor reported "adenocarcinoma of cylindroma type," and in another case the pathologist reported "Grade 4 neoplasm," without further identification.

RESULTS

Of the 139 patients included in this series recent information was obtained about all but 5 patients. Although information about these 5 patients has not been obtained recently, several of them are known to have been alive and well from one to six years since they were treated. Therefore, we have not hesitated to tabulate them with the other patients, if only to show how long they are known to have survived (Table 1).

In Table 1 the 139 cases are distributed according to how long the patients have survived or when they died since treatment with roentgen rays. From this table it may be seen that 61 patients are known to have died within one year; some of these died soon after treatment (a few weeks or months), and in 1 case the patient died before the course of treatment could be completed. In these cases, obviously, the malignant process had been more than usually extensive, and the general condition of the patients had been bad before the treatment was started. This had been recognized, but treatment had been given nevertheless in the hope of obtaining for the patients substantial, though temporary, improvement. The other 5 patients were living and apparently well when they were last heard from less than one year after treatment; since these patients were treated so recently, however, too much significance cannot be placed on their appearance of well-being at that time.

In some of these cases not only the malignant condition in the larynx had been extensive, but adjacent structures had been

invaded, or lymph nodes in the lower part of the neck had been involved. Under these circumstances, the chance of complete regression was small. When, besides extensive local involvement, the process already has extended to lymph nodes in the upper half of the neck, the prospect of cure is not great. But when, besides the foregoing conditions, lymph nodes just above or behind the clavicle have been invaded, complete regression is practically out of the question.

within one year, represent a large percentage of the entire series. There is no doubt that these 91 patients had died so soon because the malignant tumors with which they had been afflicted had been most extensive. Undoubtedly the grade of malignancy also had played an important part.

The first impression is one of doubt concerning the advisability of treatment in such unfavorable cases. And yet, the great majority of the patients had obtained sub-

TABLE I

DISTRIBUTION OF PATIENTS ACCORDING TO TIME OF DEATH OR SURVIVAL PERIOD

Year Treated	0–1 yr.		1–2 yr.		2–3 yr.		3–4 yr.		4–5 yr.		5–6 yr.		6–7 yr.		7–8 yr.		8–9 yr.		9–10 yr.		10–11 yr.	
	D	L	D	L	D	L	D	L	D	L	D	L	D	L	D	L	D	L	D	L	D	L
1936	4		2		1											1						2
1937	3				1		1															
1938	4		3															2				
1939	2		2		1									1								
1940	6		2							1		1				2						
1941	8		3		2							1										
1942	6		2	1	3					1		2										
1943	12		3		2		1		1	1												
1944	12	2	8		3	3		1														
1945	4	3	5	5		2																
Total	61	5	30	6	13	5	2	1	1	3		4		1		3		2				2

In some cases it is likely that, besides lymph nodes in the lower part of the neck, which are known to be involved, other nodes which cannot be seen or felt are also affected.

In 30 out of 36 cases the patients are known to have died between one and two years after treatment. When the other 6 patients were last heard from, all were living and apparently well at that time (recently). One of these patients had had exceptionally extensive involvement and how long he may remain well is uncertain. Another of these 6 patients was operated on at least twice after the course of roentgen treatment for reactivation of portions of the malignant process. It is plain that the 30 patients who died in this second group of cases, together with the 61 patients in the first group, who had died

stantial improvement. In some cases, within two or three months after the completion of treatment, the neoplastic process had disappeared, and the patients' general condition had greatly improved and often this improvement had continued for many months, to be followed by fresh activity of the malignant condition and by death. In other cases treatment had not caused the primary neoplasms and their secondary extensions to disappear completely, but marked regression and general improvement had occurred, and this had continued for a variable period. When, for from several months to two years, treatment is followed by marked or complete abatement of symptoms and by pronounced improvement in general condition, no one can question its value. After all, complete and permanent cure is not the only criterion of a

method of treatment; in truth, this criterion is valid only in carefully selected and favorable cases. To practice medicine means not only to try to cure patients when this is feasible, but also to relieve suffering in any form when a cure is impossible.

Five patients are known to have survived between two and three years, 1 has thus far survived between three and four years, and 3 are living and well between four and five years. Four are living and well between five and six years, 1 is living and well between six and seven years, 3 are living and well between seven and eight years, 2 are living and well between eight and nine years, and 2 patients are living and well between ten and eleven years.

From Table I it may be seen that, out of 139 cases in the entire series, 71 patients were treated between 1935 and 1942, inclusive; of these we have not been able to obtain recent information concerning 3 cases. This leaves 68 patients in this series who were treated during this period and who are living more than five years since their treatment at the Clinic. As percentages of "cured cases" go, this proportion is not as high as might be expected but, considering the initially unfavorable character of all these cases and the extensive malignant neoplasms from which the patients suffered, even this percentage seems worthy of consideration. There is no doubt that, if these patients had not been treated in the manner which has been described, all of them must inevitably have died in a very short time. Moreover, this percentage does not give any idea of the pronounced relief of symptoms and improvement in general condition which, in the patients who have died, had occurred after treatment.

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DISCUSSION OF PAPERS BY DRS. GOODRICH AND LENZ, AND DRS. DESJARDINS, FIGI AND VAUGHAN

DR. LOUIS H. CLERF, Philadelphia, Pa. I am happy to have the opportunity to discuss these two interesting contributions. Chondronecrosis has always been one of the unhappy complications of radiation therapy, but fortunately we do not see it nearly as often now as in previous years.

I agree with the first speaker regarding not irradiating patients who have been operated upon by laryngofissure and partial laryngectomy and where cartilage remains. I have had several unhappy experiences in this field. We selected laryngofissure plus irradiation and ended up with marked edema of the larynx, partial loss of cartilage, and permanent tracheotomy. I believe it safer if the surgeon selects a more radical procedure, and if surgery is elected, then dispense with irradiation. The end result will be infinitely better.

Drs. Goodrich and Lenz also mention removal of cartilage preliminary to irradiation. That has been done quite extensively in this country by Dr. Arbuckle of St. Louis, and his preliminary reports seem to be encouraging. The question has arisen whether it would not be better, when doing surgery, to remove the larynx, doing a palliative laryngectomy, rather than removing the cartilage only, which is a formidable procedure, too. I believe better results can be secured by doing a palliative laryngectomy.

On the question of tracheotomy and the advantage of low tracheotomy in order to avoid further complications, I believe that if one removes only a segment of a tracheal ring, rather than doing the conventional tracheotomy and cut two or three rings, it will lessen the chances for necrosis, and also permits one to place the tracheotomy tube at a low point.

Laryngectomy or any surgical procedure following radionecrosis is difficult. In two instances where laryngectomy was done following intensive therapy one had a recurrence of growth plus necrosis; in the other I was unable to demonstrate recurrence until after the larynx had been removed. Now laryngectomy can be done with greater safety because of antibiotics which diminish infection.

Those of us who believe that cancer limited to the larynx is best treated by surgery rather than other methods must compliment Dr. Desjardins and his associates for the excellent results they have secured, for, after all, his group of cases were not considered surgical problems. Knowing New and Figi and the group at the Mayo Clinic, I know their views with regard to surgery, and when they turn over a patient to the radiologist for irradiation, the assumption is that it is not a surgical problem. As he has emphasized, we laryngologists are sympathetic with you, but we consider our five year rates much better than yours if the case is still a surgical problem.

The author well stated that if one contemplates treating only those patients whom one can cure, one will not have many and that is true. One must treat many patients, not with a view to curing them but relieving them of some of their difficulties, and, if possible, prolonging life. That certainly applies to carcinoma of the larynx and one is justified, in the inoperable case, in proceeding with this technique.

There was a time when I considered irradiation as a form of euthanasia, because when intensive irradiation was started, the patient made a very rapid decline and had a wretched time during his remaining days. I wondered whether tracheotomy, plus nerve injection to relieve pain, and tube feeding did not give equally good results. The situation has changed a great deal in recent years and we, too, have some five year cures in patients that we said were not good surgical cases because we did not feel we could remove the carcinoma.

We have also made advances in the field of surgery, so much so that laryngectomy and block dissection of the neck can be carried out; with the antibiotics infection is uncommon and fistulas are rare. We can now contemplate doing laryngectomy and a radical block dissection, provided the metastasis still is confined to the neck. I believe a combination of surgery plus irradiation is probably going to offer more in these cases than either one or the other, and I do further believe that the future of carcinoma of the larynx, particularly in advanced cases, is much more cheerful now than it was a few years ago.

DR. DOUGLAS QUICK, New York, N. Y. I thank you for the privilege of discussing this very excellent and, at the same time, very unusual paper by Dr. Desjardins and his associates. At an earlier period in the half-century, or less, of therapeutic radiology our experiences, reports, and discussions were of necessity limited to advanced cases. As we have progressed, the advanced material has received less and less of our active consideration. In this present instance, we have a most excellent and able presentation on the treatment of the material cast off by the Department of Surgery in an institution recognized internationally as a surgical or surgically minded institution. Not only has this advanced material been cheerfully and ably treated in an individualized manner, but, in reporting it, the authors have given the center of the stage to their surgical confrères by quoting, in detail, the excellent operative statistics from the Surgical Department. The explanation is to be found, I believe, in a paragraph toward the end of the paper, as follows: "To practice medicine means not only to try to cure patients when this is feasible but also to relieve suffering in any form where a cure is impossible." The care of this group of patients has been the work of the physician rather than that of the technician. The distinction between cure and palliation has obviously been kept constantly in mind, as indicated by the varying of dosage factors and time intervals, depending on the reaction of the individual from day to day. Any discussion on this report must, of necessity, be in the nature of expressing approval, emphasizing certain points, or offering possible minor suggestions.

For the purposes of strict clarity, I would rather have referred to this group of cases as cancer of the "larynx and hypopharynx" or "larynx, intrinsic and extrinsic," rather than just "larynx." The larynx group, strictly speaking, embodies a more limited group, anatomically and histopathologically, and a group more favorable, in fact, from the standpoint of roentgen therapy. The results here reported are more difficult of attainment by reason of the vagaries of the diseases and the anatomic areas involved.

In my judgment, carcinoma of the hypopharynx or extrinsic larnyx is never "operable" although it frequently comes to the therapeutic radiologist after it has been operated upon or at.

The number of preliminary tracheotomies reported in this paper attest the advanced character of the disease on admission for treatment. The small number necessitated during treatment indicates the care with which treatment was carried out. It has been my experience that small initial doses, with gradual daily increase, frequently gets by in the border-line case where heavy initial exposures would precipitate the need for tracheotomy. I would like to commend and endorse the suggested maximum daily exposures here advocated. In my experience, the total of daily exposure over 300 r, in air, does more harm than good and precludes an otherwise much higher total dosage tolerance.

I believe the total dosage, here indicated, is about as high as it is safe to go with the factors indicated and with palliation only as a constant consideration. It is my feeling, and with due deference to the physicists, that a somewhat higher total tumor dose can be delivered, in the ultimate, if the skin-target distance is increased well beyond 50 cm. I feel quite sure, clinically, that this is possible in using the smaller fields with earlier and, anatomically, less extensive lesions. With these earlier growths, also, I prefer three fields rather than two. The use of three fields permits of a more practical uniform distribution of the radiation within the limits of everyday technical adjustment.

I have no opinion on a maximum treatment interval—whether it be thirty or sixty days—the response and reaction of the patient from day to day, especially the advanced case, is more important than adherence to technical rote, ending, perhaps, in a casualty.

When lymph nodes are involved, in the cervical area, it has been my experience that, except for the totally undifferentiated growths (Grade 4), radium, by implantation of radon seeds or element needle transfixion, has something definite to offer from the standpoint of palliation or possible "five year cure" as a supplement to roentgen therapy. The nausea attendant upon treatment is a problem of practical importance. All too often, it is due to overdosage in the daily exposure. Routine periodic throat irrigations, to eliminate mucus and the resultant gagging, eliminates some cases. We are all familiar with the value of liver extract and the B-group of vitamins. The intravenous use of pyridoxine is to be commended highly in certain instances where the other measures fail. The postnasal feeding tube is to be commended for both loss of weight and, sometimes, overemphasized nausea.

In the beginning of my discussion, I noted the courtesy shown the Surgical Department in the quoting of their operative results. I hope that that department and similar departments elsewhere take note of the results achieved in the care of those patients who were beyond their reach. In addition to the comfort and palliative aid given to all of them—and this is too often overlooked—a five year survival rate of 17.5 per cent is a truly wonderful achievement. Such results demand, for irradiation, a trial in the less advanced cases; and for the more favorable and earlier cases, they demand at least a consideration of radiation on an equal basis with surgery.

Concerning the other paper by Dr. Lenz and Dr. Goodrich, I will not attempt to take time to enter into that discussion, but I would like to mention one point, and that is that it was very cheering, indeed, to have stressed both in the presentation and in the discussion by Dr. Clerf, the factor of infection as being the activating, aggravating, complicating factor. In the absence of infection, the problems of laryngeal cartilage complications are infinitely less.

DR. LENZ (closing). Dr. Quick's mention of the problem of laryngeal infection permits me to emphasize again that chondronecrosis in the presence of a small cancer was encountered only once in the 28 cases we studied. The extensiveness of the cancer destroying the perichondrium and facilitating the entrance of bacteria, more than the technique of modern radiotherapy, seems to account for laryngeal chondronecrosis after roentgen therapy of laryngeal cancer. It is unfortunate that Dr. Desjardins gets only extensive cases for roentgen therapy. Results of this treatment in small cordal cancers are as good as with laryngofissure and the voice is better. The discrepancy in the estimated distance between the center of the irradiated lateral neck field and the center of the larynx in Dr. Desjardins' and in our reports is due to a difference in the size of the irradiation fields. Dr. Desjardins' larger fields extend farther back and as the larynx is situated in the anterior portion of the neck his average distance between the centers of the irradiation field and larynx is 6 cm.; with our smaller fields this is 3 cm. The tumor dose would then be about equal to the air dose with the usual 200 kv., 0.5 mm. Cu, 50 cm. target skin distance and a circular field of 6 by 8 or 7 cm. With much larger or much smaller fields this would not hold true.

ROENTGEN THERAPY OF MALIGNANT TUMORS OF THE TESTIS*

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WITHIN a short period after roentgen therapy first was used in cases of tumor of the testis, it became obvious to many observers that true malignant teratomas are much less susceptible to the action of roentgen rays than are seminomas. The fact that seminomas are highly radiosensitive was noted by Chevassu in his thesis. The radioresistance of teratomas, on the other hand, was emphasized by Desjardins, Squire and Morton about twenty years ago. They stated that "testicular tumors of the mixed or teratoid group are influenced much less (than seminomas) by roentgen or radium rays. Moreover, their susceptibility is a measure of the degree of epithelial preponderance in the cellular composition of such neoplasms. When cartilaginous, myxomatous, or fibrous tissue is an important feature, the influence of irradiation is slight or nil. True teratomas remain practically unaffected by irradiation."

Seminomas and malignant teratomas together constitute about 95 per cent of all malignant tumors of the testis. Seminomas are encountered about six times more frequently than malignant teratomas. Both of these tumors occur during the years of greatest sexual potency but the maximal incidence of teratomas occurs earlier in life than does the maximal incidence of seminomas.

It was pointed out by Nash, Scheetz and me[5,6,7,8] that, although there are many points on which a differential diagnosis may be postulated, the only certain and absolute method of distinguishing these tumors from each other is by microscopic examination of intact tissue. Nash stated that the histopathologic characteristics of a seminoma are so definite that the tumor can be diagnosed even when sections of metastatic deposits in any part of the body are examined microscopically.

The microscopic appearance of a malignant teratoma, on the other hand, is entirely different and is characterized by the varied appearance of different portions of the tumor. In general, the tumor consists of embryonal structures arranged in such confusion as to eliminate any resemblance to an embryo. Usually, if enough sections are studied, one may identify tissues derived from all three germ layers, but by far the greatest incidence of neoplastic change is in tissues derived from the hypoblastic layer.

McDonald has tersely summarized the difference in the microscopic appearance of these tumors in the following statement: "Seminomas show monotonous uniformity of structure and cellular composition; teratomas, an endless variety."

The difficulties of classifying tumors of the testis were pointed out by Nash and by Scheetz, both of whom called attention to the complexity of terminology in the literature, which has confused rather than clarified the conception of testicular tumors. Both of these authors have adopted the classification of Broders, because it seemed to them to be inclusive, simple and useful. Whether these tumors originate from the same source or from different sources is not particularly important as far as the usefulness of this classification is concerned. They stated that it is sufficiently inclusive to embrace all common varieties of malignant epithelial tumors of the testis; further subdivision would seem to be super-

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fluous, unnecessary and in most cases impossible.

Broders has divided tumors of the seminal epithelium into three main groups: (1) teratomas, (2) adenocarcinomas of the seminoma type, and (3) adenocarcinoma of the testis. The teratomas were subdivided into two groups: (1) benign teratomas, and (2) malignant teratomas.

The adoption of Broders' classification, it seems to me, would go a long way toward correcting the confusing and contradictory views about testicular tumors.

I regard the report of the microscopic examination of intact testicular tissue as of fundamental importance in planning roentgen therapy for a patient with a tumor of the testis, because there are, on the one hand, the seminoma which is radiosensitive and has a relatively good prognosis, and, on the other hand, the malignant teratoma which is usually resistant and has a poor prognosis. A distinction by the pathologist of seminoma from malignant teratoma, therefore, gives the basic indications on which roentgen therapy may be planned.

Since there is no way by which the extremely important diagnostic, therapeutic and prognostic questions can be settled with finality other than by histologic examination of tissue obtained from the testis, it follows as a corollary that the tissue should be intact, should not be altered by extraneous influences and should be truly representative of the structure of the tumor in question. It is the opinion of physicians at the Clinic who have treated patients with these types of tumors that suitable tissue is best obtained by simple orchectomy without preoperative irradiation.

Simple orchectomy, in addition to providing information that is of value from a diagnostic and prognostic standpoint, eliminates infection and discomfort in cases of a large scrotal tumor. In addition, it removes a focus from which metastasis may take place. Because a diagnosis of the presence or type of testicular tumor cannot always be made after the histopathologic appearance of the tumor has been changed by irradiation (a fact that was emphasized by Nash), orchectomy is advised both as a diagnostic and therapeutic procedure even in the presence of known metastatic lesions in all but very exceptional cases. As far as can be determined from the literature, most American surgeons prefer simple orchectomy to a more radical operation.

After a brief period of postoperative convalescence (usually a few days) it is our practice at the Mayo Clinic to administer a course of postoperative radiotherapy. Recently malignant teratomas have been exempted. For this course of treatment, radium was used in the early days, but because roentgen therapy is, as a rule, more practical, more efficient, and more expedient than radium therapy, radium is now seldom used except for the occasional treatment of a small metastatic lesion in the supraclavicular region or, possibly, for a small localized recurrent lesion in the scrotum. This procedure is in accordance with the general practice of most radiologists.

In postoperative treatment many roentgenologists apply the roentgen rays only to an inguinal field or to one or more abdominal fields and do not irradiate above the diaphragm unless there is definite evidence that metastasis has occurred at this site. Some authors have stated that they routinely irradiate the abdomen through one or two large anterior or posterior fields; the rays are generated at 200 kv. and the dose is in excess of 500 r. A few have stated that they irradiate the thorax. Treatment of the supraclavicular space seldom is mentioned as a prophylactic postoperative procedure. Lumbar and sacral fields are commonly irradiated in the treatment of teratomas but they are seldom treated in cases of seminoma. It must be admitted in fairness, however, that in evaluating techniques of irradiation one must be wary of the term "teratoma" because it is often used erroneously, I think, as a generic term for all testicular tumors, whereas it should be used to designate a specific testicular neoplasm. As has been indicated previously, many radiologists prefer to use roentgen rays

generated in the neighborhood of 200 kv. and heavily filtered. Some authors believe that roentgen rays in the "supervoltage" range have superior qualities. Just as the number of fields treated varies widely, the dose for each field varies from 500 r to 4,000 r.

For a long time it has been the view of the members of the Section on Therapeutic Radiology of the Mayo Clinic that the techniques of palliative and curative treatment should often be different; that a radiosensitive and a radioresistant tumor should not necessarily be treated in the same way; that an old or debilitated patient should receive milder treatment than a young or vigorous one; that clinical, physiologic and pathologic data are of equal or even of greater importance than are most physical factors in outlining the treatment for a patient; that the patient should not be killed by a lethal dose of roentgen rays in order to obliterate the tumor; that the quantitative aspects of dosage often are less important than the method by which treatment is given; that injury of the skin is generally of less importance than severe injury of the formed elements of the blood or permanent injury of a viscus adjacent to the tumor; that injuries to the patient are in general directly proportional to the magnitude of the radiation that is absorbed; that in comparable doses high voltage roentgen rays are more injurious to deep-lying structures than are moderate voltage roentgen rays; that a technique suitable for carcinoma of the pharynx cannot be applied without much modification and reservation to the treatment of sensitive tumors in the abdomen, because of the different geometric and physiologic considerations involved; that the application of gamma rays (or roentgen rays approaching the wavelength of gamma rays) as such confers no immunity on either the skin or on normal structures and does not increase the radiosensitivity of any tumor; that the best clinical indication of the magnitude of the volume or the tissue dose is the leukocyte count, and finally, that precise radiotherapy is subject to all the variations, confusions and disappointments of other methods of treatment used in all other clinical fields, because the living world knows no constants. For a long time we have regarded these truths as self-evident; they are the basis of our ideas about radiotherapy but it must be admitted that they are at variance with those of many radiologists.

It is my present opinion that irradiation of seminomas of the testis and their secondary deposits is best carried out as a rule with roentgen rays of moderate voltage (130 to 140 kv.). This opinion is based on a rather large experience. This type of treatment is used because I know of no proof of the superiority of higher voltage roentgen rays, particularly rays generated at 200 kv. or more. Sometimes, in fact, I have seen patients with metastatic lesions in the abdomen who have not responded well to large doses of high voltage roentgen rays that have been administered elsewhere and I have observed that the application of moderate doses of rays generated at 130 kv. caused the lesions to disappear. Furthermore, prophylactic postoperative treatment, if it is to be truly protective against metastasis, should be applied to *all* lymphatic pathways through which metastasis may take place. This, obviously, makes extensive treatment necessary. The risk of such treatment is greater with rays generated at higher voltages, because the irradiation of the fields which usually should be irradiated as a prophylactic measure produces more reaction and more destruction of leukocytes and increases the risk of injuring normal viscera. I do not feel that a patient should be subjected to the risk of injury from roentgen treatment unless there is some valid indication for such an injury, and to my mind prophylaxis should not necessitate injury.

At the Clinic we routinely irradiate four anterior abdominal fields extending from the xiphoid cartilage to the pubic region (two each side of the midline)* and four

* These are omitted if we are quite certain that there are no metastatic lesions in the abdomen.

corresponding posterior fields. The mediastinum and the left supraclavicular space also are always treated. Each field receives a total dose of about 540 r (in air). One or two fields are treated daily, depending, of course, on the patient's tolerance and especially on the leukocyte count. This course of treatment is repeated in a month. If metastatic lesions have been present in the abdomen before operation, a third course is given after a lapse of two months.

For seminomas of the testis, the doses used at the Clinic are low in comparison with those used elsewhere; we feel that the use of rays generated at high voltage or more intense treatment generally is not indicated for seminomas—the high radiosensitivity of which has been universally recognized—since not only are the published results of more intense treatment used elsewhere no better than our results but the technique usually entails more risk to the patient. Incidentally, in the treatment of at least 500 testicular tumors in a period of twenty years, we have never had a death which could be attributed in any way to roentgen therapy. That our methods of treatment have proved satisfactory is confirmed by the statistical study which Cabot and Berkson made of the results of treatment of these lesions. They found that in all cases of seminoma of the testis the five year survival rate was 67.7 per cent, whereas in cases of all other malignant tumors of the testis the five year survival rate was 29.3 per cent. Of all patients who had seminomas and who received roentgen therapy, 71 per cent lived five years or more. In the cases in which roentgen therapy was not employed, the five year survival rate was 58.8 per cent. In general, in cases in which there is no evidence of abdominal metastasis at the time of irradiation, the three year survival rate is twice as high as it is in cases in which metastatic lesions are present in the abdomen. Two-thirds of the patients who do not have metastatic lesions in the abdomen live at least three years. The presence or absence of metastatic lesions in the abdomen obviously is of the greatest importance both from the viewpoint of roentgenologic technique and of prognosis.

The symptoms of metastatic involvement of the para-aortic lymph nodes have been ably described by Desjardins and their importance has been pointed out by Nash and by Scheetz.

Involvement of these nodes by metastatic deposits from testicular tumors probably takes place earlier in cases of malignant teratoma than it does in cases of seminoma. Involvement of those nodes frequently produces a dull aching pain in the back which is often called "lumbago" by the patient. The pain may extend into the hip or leg and is often attributed to sciatica. Bloating, belching, fullness in the abdomen after meals, and constipation commonly occur after the para-aortic nodes have become involved. When the epigastric nodes are the site of secondary deposits, symptoms referable to the abdominal viscera may occur so suddenly as to simulate an acute disease of the abdomen. Desjardins has pointed out that, although it is sometimes difficult to be certain of metastatic involvement of the para-aortic lymph nodes in many cases, a diagnosis can be made on the basis of the history and the physical findings. When a definite mass cannot be palpated, only deep abdominal resistance may be found and pressure by the examiner's hand at the site of this vague resistance elicits tenderness which is not found when similar pressure is made on a normal abdomen. When the metastatic lesion in the abdomen has become sufficiently large it may be palpated easily as a smooth or irregular firm, immobile mass, lying most often on the side of the abdomen corresponding to the diseased testis or toward the midline in the epigastric region. In certain cases, special techniques of roentgenography or urography may give definite indications of metastatic involvement of the para-aortic lymph nodes.

In the presence of any of these signs or symptoms, the best practice is to institute treatment for a metastatic lesion; even if

the evidence regarding the presence of such a lesion is vague or inconclusive it is advisable to institute treatment.

Metastatic involvement of one or more of the left supraclavicular lymph nodes is the forerunner of involvement of the peribronchial nodes and is usually secondary to involvement of the lymph nodes in the upper part of the abdomen. The enlargement of left supraclavicular nodes of a man is an urgent indication for examination of the testes. In cases of malignant teratoma, involvement of the supraclavicular nodes occurs more often and earlier in the course of the disease than it does in cases of seminoma.

Enlargement of the inguinal lymph nodes is not definite evidence of involvement by metastatic deposits from testicular tumors. Such metastasis is evidence that the tumor of the testis has perforated its capsule and has spread to trunks draining into the groins. The diagnosis of metastatic involvement of the inguinal nodes, therefore, should be supported by definite evidence that the tumor actually has involved the capsule and also by biopsy of an enlarged lymph node.

Since it is well known that seminoma of the testis responds well to roentgen therapy the therapeutic test can often be used with high accuracy to judge the nature of metastatic lesions when their histopathologic structure is unknown. Some tumors may be a mixture of a seminoma and a teratoma. In this case, the initial response of the tumor may be satisfactory because the seminoma is destroyed; however, after the initial response has taken place, the residual tumor, which is made up of more resistant cells, may not respond and the tumor may grow in spite of treatment.

For the treatment of seminomas, roentgen therapy has assumed a position of prime importance and has altered the prognosis from one of hopelessness to one of subdued optimism.

This is quite different from the prognosis of malignant teratoma of the testis. The study by Scheetz showed that the experience of roentgenologists in the past few years and the results that they have reported confirm the remarks which Desjardins, Squire and Morton made twenty years ago about the lack of response of these tumors.

It might be stated in brief that no technique of treatment which we have used within the limits of safety has been more than temporarily effective in the treatment of metastatic lesions caused by malignant teratomas.

Scheetz, who reviewed 54 cases of proved malignant teratoma, concluded that the only manner in which a cure may be obtained in cases of malignant teratoma of the testis is by performing orchectomy before metastasis has occurred. He said that this objective can be attained in less than a third of all cases. He did not think that roentgen therapy appeared to have any beneficial effect on malignant teratoma of the testis, which is extremely resistant to roentgen rays. After metastasis, death usually occurred within eighteen months. Ironically enough, in the case in which the patient survived for the longest time, that is for twenty-four years, postoperatively, radiotherapy was not employed. Scheetz felt that the patients who lived for an appreciable period after operation were fortunate enough to have undergone orchectomy when the teratoma still was confined to the testis. In the cases in which the patients had died, it seemed likely that metastasis had occurred before operation was performed but that the metastatic lesions had not been large enough to produce clinical signs or symptoms at the time when the patients first were examined at the Clinic.

Since the radiosensitivity and, therefore, the prognosis of seminomas are completely different from the radiosensitivity and prognosis of malignant teratomas, we feel that our insistence on accurate pathologic diagnosis as a basis for roentgen treatment is justified. Because the method of treatment we use is as effective as any reported, is safer than many types of treatment and

is based on extensive experience, we can see no sensible reason for changing it.

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PRELIMINARY REPORT ON THE CLINICAL USE OF RADIOACTIVE IODINE (I^{131})*

By EARL R. MILLER, M.D., MAYO H. SOLEY, M.D., *and* MORRIS E. DAILEY, M.D.

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RADIO-IODINE is the element iodine made capable of spontaneously disintegrating and emitting radiation, either beta particles, or beta particles and gamma rays. It is useful in therapy since this radiation may destroy the cells which absorb the iodine, and useful in tracer work since it allows one to follow the fate and metabolism of the iodine by observing the radiations emitted from it. There is no difference in the metabolism of radioactive and of non-radioactive iodine. However there are eleven different radioactive isotopes of iodine which differ enough in radiation action on the thyroid even with the same number of millicuries absorbed, that they might well be considered as different substances. This is true because the different isotopes have marked differences in their half-lives and their radiations have markedly different energies.

This is well reflected in the case of I^{130} and I^{131}, both of which have beta and gamma radiation. The energy of the radiation from the I^{130} is much greater than that from I^{131}. The half-life of the I^{130} is 12.6 hours and that of I^{131} is eight days. Therefore, the I^{130} will act with great effect over a short time and the I^{131} will act with less effect per unit time, but will act over a very long time. This difference will make a great difference in the dose administered to accomplish the same end. This difference may be as much as fifty times.

Radio-iodine is useful in the treatment of Graves' disease in which the thyroid is not saturated with iodine. It is not useful in the therapy of Graves' disease in which the thyroid is saturated with iodine, nor is it useful in the treatment of thyroiditis, nontoxic goiter, or involutionary nodules in the thyroid. It is occasionally useful in therapy of carcinoma. In the first condition the thyroid can and does take up and hold tenaciously a great deal of the iodine, is subjected to the radiation from it and the radiation will control the disease. In the other conditions the abnormal tissue in the thyroid will not take up the iodine and therefore cannot be subjected to the radiation from it, even though radiation may be effective in controlling the disease.

This study was made in order to determine if possible the uptake of radio-iodine in microcuries in the human thyroid in situ after oral administration of I^{131}. From this, an estimate of the energy dissipated within the thyroid can be made. If the weight of the thyroid can be determined and one is willing to assume that the distribution of the iodine, and therefore the radiation, in the gland is uniform, then the dose can be converted to roentgens as outlined by R. D. Evans.[1] This has the merit of giving the dose in terms comparable with those used in already established roentgen therapy and in terms with which the radiologist is already familiar.

But it is known that the distribution of radio-iodine in the thyroid is not uniform and the estimation of the weight of the gland is subject to error even in well trained hands. It would seem therefore, that it would be better to describe the dose in microcuries of I^{131}, in the thyroid, rather than to attempt to give it in roentgens. Our curves show that an estimate of thyroid weight is necessary to arrive at an accurate estimate of the amount of I^{131} in the thyroid, but an error in estimation of the weight of the thyroid will introduce a rel-

* From the Divisions of Radiology and Medicine of the University of California Medical School and Hospital, San Francisco, California. Presented at the Forty-seventh Annual Meeting, American Roentgen Ray Society, Cincinnati, Ohio, Sept. 17–20, 1946.

atively small error in the estimate of the uptake in microcuries of I^{131}, if proper conditions for measurement are chosen.

The iodine solution is calibrated in microcuries per cubic centimeter. This is done by taking 1 cc. of the stock solution, diluting to 100 cc. with water, drying 1 cc. of this on a porcelain dish and determining its beta activity by means of a calibrated thin aluminum windowed Lauritsen electroscope. The measured millicuries were the same in Oak Ridge as in California.

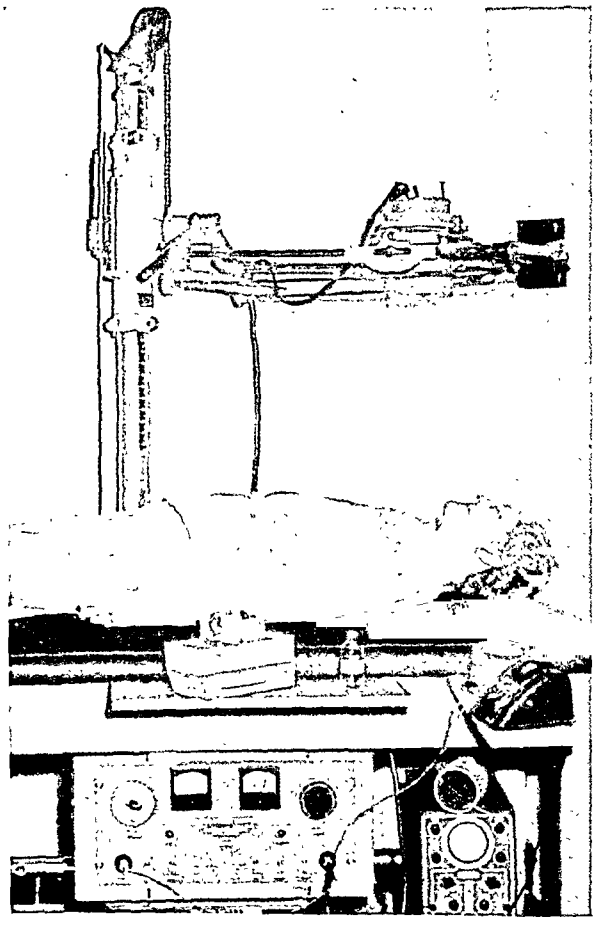


FIG. 1. Apparatus for measuring the amount of I^{131} in the thyroid. Directly above the patient's neck is a lead cylinder containing the Geiger-Müller tube. On the shelf at the side of the patient, stands a 60 cc. standard serum bottle containing the known amount of radio-iodine. To its left, also on the shelf is shown a similar bottle lying on a wooden phantom which resembles the neck in size, in order to equalize back-scatter from the specimen and from the neck. To the right, on the small shelf are the register and timer for the scaling circuits; below to the left is the scaler for the Geiger counter and to the right below is the oscilloscope.

The dose of the solution in cubic centimeters is determined by dividing the dose to be given in microcuries by the number of microcuries per cubic centimeter. The iodine solution is put into about 50 cc. of water and the patient drinks the entire solution. The glass is then washed in about another 50 cc. of water. This is given to the patient who washes his mouth with and drinks this water. This is repeated once.

The iodine is administered in the evening and measurements are made on the patients during the following two days during the daytime. Follow-up measurements are made at one and two week intervals. The patients are re-evaluated clinically and with laboratory tests at the end of a month to determine their status and possible need for more treatment.

The Geiger counter is used vertically (Fig. 1). It is encased in a lead cylinder with 1 inch walls. The front surface of the lead cylinder is covered by 1 mm. of lead filter. The front surface of the Geiger counter is 7 cm. behind the lead filter. The sample of radio-iodine or the patient's thyroid, is placed at a known distance (22 to 46 cm.) from the front of the cylinder, making the front of the counter 29 to 53 cm. from the specimen. The front opening in the cylinder is 2 inches in diameter. The area that the tube "sees" is a circle varying in diameter with the distance, up to 14 inches.

The long distance between the sample and counter used in these measurements was chosen so that the error due to the depth of the thyroid in the neck and the error due to the depth in the thyroid from which the gamma ray originated would be minimized. Also it was thought that the effect on the counts due to the change in the size of the thyroid or sample would be less at the large distance than at a lesser one.

The lead filter was used so that only the harder components of the radiation from

the thyroid would be recorded. This reduces the error due to self absorption of the radiation in the thyroid or in the sample.

Before any measurements are made, a background reading of the instrument is determined. The patient is then placed

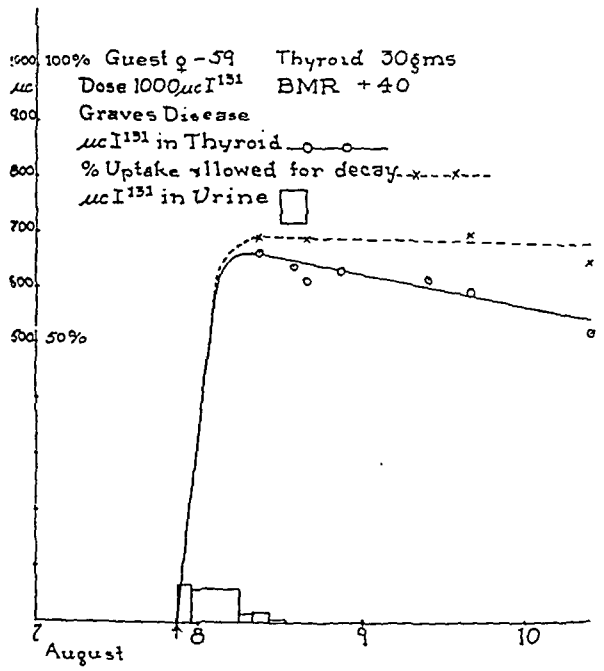


Fig. 2. Curve of uptake of I^{131} in the thyroid of a patient with Graves' disease. The solid line shows the number of microcuries of I^{131} in the thyroid after the administration of a dose of 1,000 microcuries of iodine, given on August 7, 1946, in the evening as shown by the arrow. The dotted line curve shows how much of this iodine would have been in the thyroid if there had been no decay of the iodine. Note how flat this curve is. If the dotted curve were horizontal it would mean that no radio-iodine left the thyroid once it had been deposited there. The bar graph along the abscissa shows the amount of I^{131} in specimens of urine collected as shown in time.

supine on a table, so that the isthmus of the thyroid is directly under the center of the counter. The reading is taken in this position. The counter is then moved over the thigh just above the knee, using the same distance from counter to skin and the count is again taken. This area was chosen because it will be noted that the diameter of the thigh just above the knee is about the same as that of the neck. This should allow

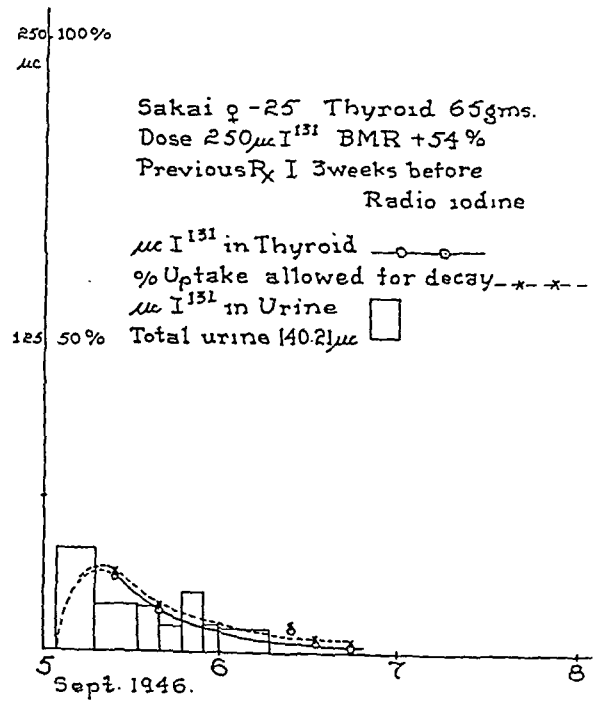


Fig. 3. Shows the uptake of I^{131} in the thyroid of a patient with Graves' disease who had been treated recently with inert iodine. Note the very small uptake of radio-iodine in this case as compared with the case of the untreated Graves' disease.

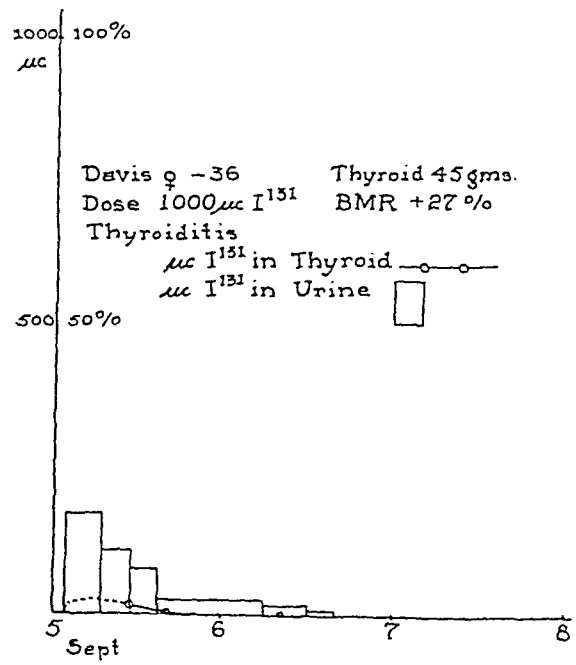


Fig. 4. This shows the uptake of I^{131} in a patient with thyroiditis. Note that the uptake here is so small as to be hardly measurable.

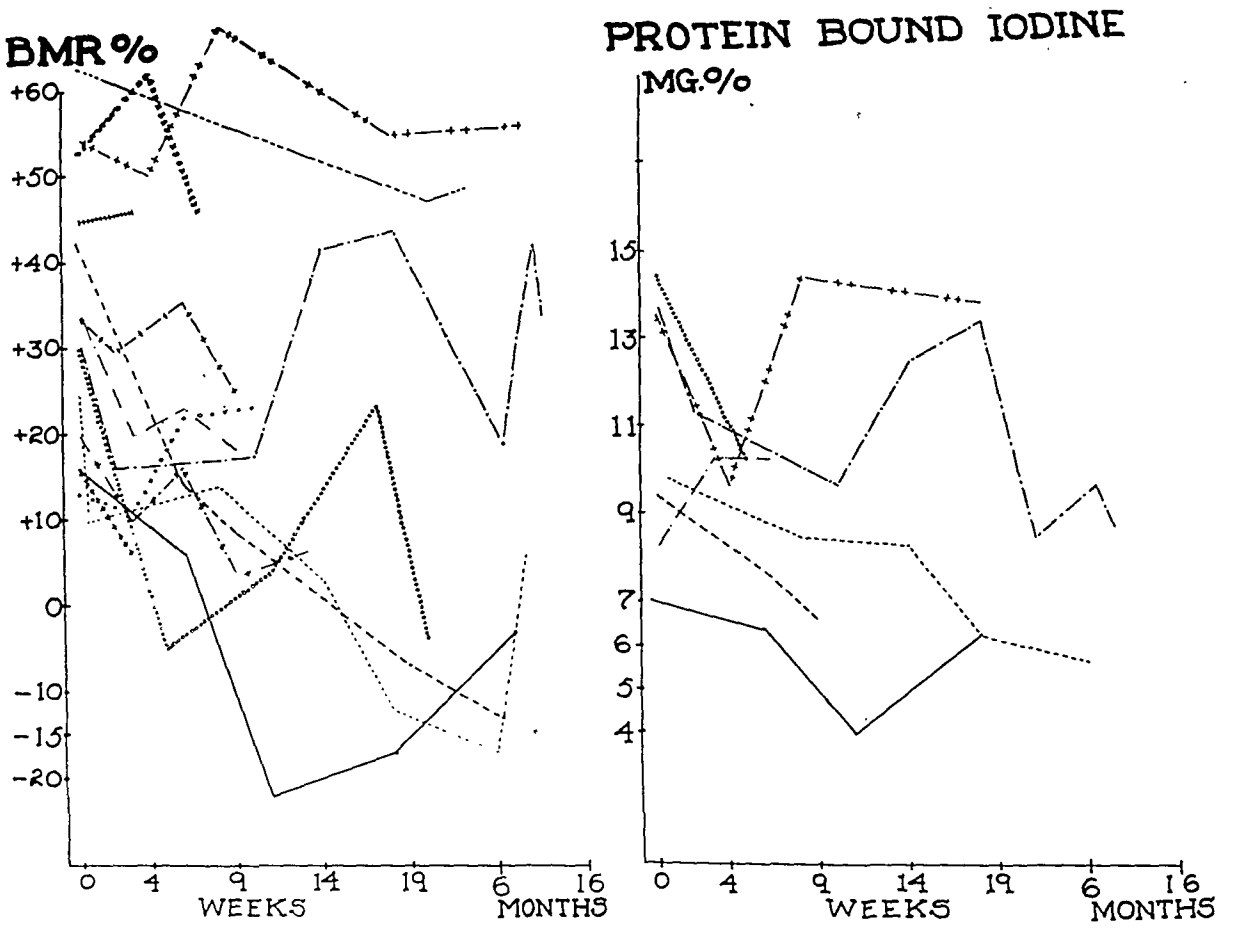


FIG. 5. These are composite curves of the results on the basal metabolic rate and protein-bound iodine of patients with Graves' disease treated with small doses of I^{131}. It will be observed that in general the basal metabolic rates fall at first and then rise. This is because the doses were too small. Also, note that in patients with extremely high basal metabolic rates the small doses of iodine were almost entirely ineffective. The curve of the protein-bound iodine reflects similar effects.

us to subtract the reading taken over the thigh from the reading taken over the neck and thyroid and leave the reading due only to the thyroid. The distance usually chosen is 22 cm. if the dose is about 250 microcuries, and 46 cm. if the dose is 1 millicurie.

A 60 cc. cylindrical bottle, filled with an aqueous solution of radioactive iodine of known potency, is then placed in front of the counter at the same distance. The reading from this is taken. This bottle is approximately the same size as the thyroid and is about as deep as the thyroid is in the neck. The number of counts per minute per microcurie in the iodine solution is determined. This is used as a standard for determining the number of microcuries of radio-iodine in the thyroid.

A sample calculation follows:

Patient: C.J. Date: 8-8-46	Time: 4:45 P.M.
Counts over neck (46 cm.)	454 C×8/min.
Counts over thigh (46 cm.)	32 C×8/min.
Therefore, counts due to thyroid	422 C×8/min.
Iodine standard (146 microcuries, 46 cm.)	104 C×8/min.
Background	16 C×8/min.
Counts due to 146 microcuries	88 C×8/min.

Therefore, $\frac{88}{146} = 0.602 =$ number of C×8/min. due to 1 microcurie

$$\text{Number of C×8/min. due to thyroid} \over \text{Number of C×8/min. due to 1 microcurie} = \frac{422}{0.602} = 701 \text{ microcuries } I^{131} \text{ in the thyroid.}$$

If this patient had been given 1,000 microcuries of radio-iodine, at the time of measurement, he would have had 701/1,000 or 70.1 per cent retention in the gland. This type of calculation tells one what the gland contains at any given time and the results can be plotted as a function of time.

One can also plot the results, taking into account the decay of the iodine. In this case, one would plot the results as a percentage of the dose taken up and retained by the gland as a function of time. This type of curve shows to better advantage how tightly the thyroid retains the iodine it selects from the blood stream (Fig. 2, 3, and 4).

The results of treatment with small doses of I^{131} are shown in Figure 5.

Doses of I^{131} in these patients varied from 800 microcuries in a single dose to 250 microcuries per week for six weeks. The curves show that the basal metabolic rate and protein-bound iodine return toward normal after administration of radio-iodine, but it is obvious that the doses are too small. This was predicted before this series of patients was treated, but adequate supplies of iodine were not available and

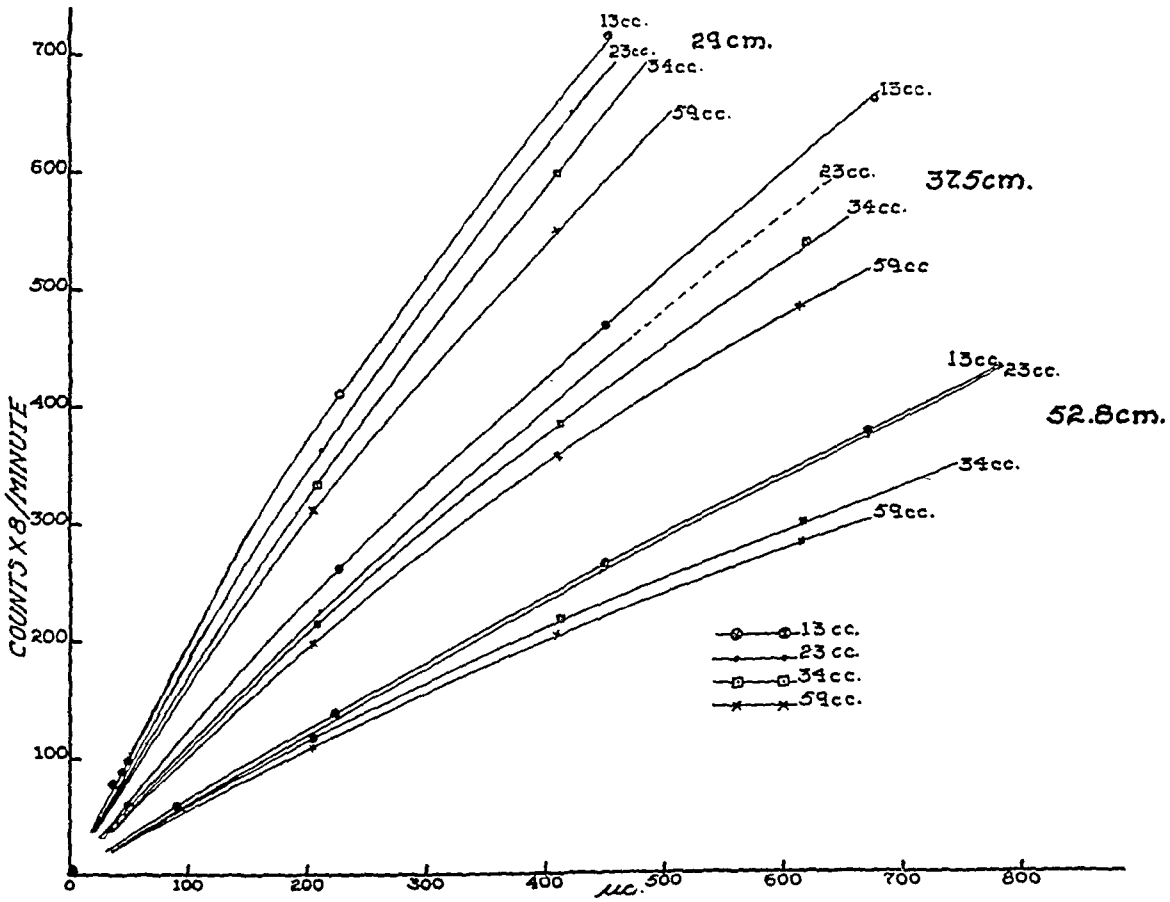


Fig. 6. These are curves obtained by using various amounts of stock solution of radio-iodine and measuring different size containers at different distances in order to determine whether the response of the counters was linear, to study coincidence counts and to study the geometry of the counting. It will be noted that all of the lines are curved so that the number of counts per microcurie varies with the size of the bottle and the distance at which it is measured. If each of these curves were a straight line through the origin then the number of counts per microcurie would be independent of the size of the bottle or thyroid. Since these are not straight lines through the origin, the number of counts per microcurie varies with the size of the specimen and number of microcuries in the specimen. Therefore, it will be necessary in the future to do calibration curves such as these for each new stock solution.

we felt it would be wise to proceed cautiously until methods of measurement were more sure.

As these studies proceeded it was noted that a sample of iodine used as a standard gave a systematically larger number of counts per microcurie as it decayed. It was thought at first that the sample might be a mixture of isotopes or that the beta-gamma ratio of the sample changed with time. There was no change in the geometry of the system during these measurements. Because of this finding the curves shown in Figure 6 were obtained, showing counts times eight per minute plotted against microcuries of I^{131} in the sample at different distances and using different size standards.

The points on these curves were obtained with the same stock solution of iodine and were done within a period of three days, so that radioactive decay plays little part. (The curves are corrected for decay.)

The response of the counter is supposed to be linear up to 20,000 counts per minute, yet these curves show that when samples are actually measured, it appears that the response is not linear. A change in the geometry of the system is, of course, inherent in these measurements, since different size bottles are used, but this change is so small at the greater distances that one would not expect it to be of very great importance. Also there is less change as a function of distance than would be expected if the geometry were of great importance. As a consequence of this finding, the curves of uptake of I^{131} in the thyroids of the patients shown are somewhat in error. Time did not permit their correction. The actual amount taken up in each thyroid is a few per cent greater than those shown. The error will be greater in the patients with large thyroids than in those with small glands and it will be greater with small uptakes than with large uptakes.

A word of caution should be said here about handling radioactive materials. All radioactive materials are dangerous. The alpha emitters may be accidentally inhaled or absorbed through abrasions. Many of these have long half-lives and are deposited in vital structures where they may be lodged for a long time. The beta emitters are more likely to prove dangerous from local effects on hands, whereas the gamma emitters have the same general effect as roentgen rays. Radiologists, because of their training and understanding of radiations and their effects, are going to be called upon to play an important part in the medical future of radioactive materials. Proper care in the handling of these materials will make it unnecessary to write a book in the future about the martyrs to the science of radioactivity.

We wish to thank Doctor J. G. Hamilton of the Radiation Laboratory in Berkeley, California, for supplying the radio-iodine.

We understand that the iodine^{131} was supplied to the Radiation Laboratory by the Clinton Laboratories to partly compensate for the use of the Berkeley cyclotron on Manhattan Project work. Our thanks go also, therefore, to the Clinton Laboratories and to the Manhattan District.

Clinical work on the patients treated with radio-iodine was done by members of the Thyroid Clinic at the University of California.

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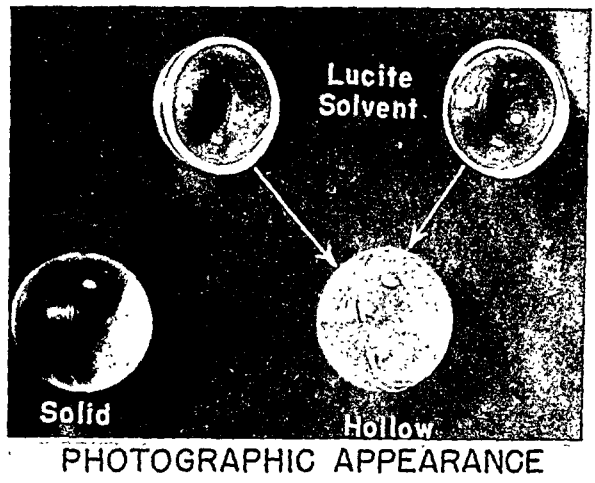
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ROENTGENOGRAPHIC STUDIES OF METHYL METHACRYLATE (LUCITE) PLOMBAGE IN EXTRAPLEURAL PNEUMOLYSIS*

By HERBERT D. KERMAN, M.D.†
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FIFTY-SIX years ago the first report of an extrapleural stripping procedure for pulmonary collapse was introduced into the field of thoracic surgery by Tuffier.[2] Since then many reports of extrapleural pneumolysis have appeared in the literature utilizing a variety of materials to maintain the collapse including: oil, paraffin, air, muscle, fat, surgical gauze, rubber sheeting, and even a rubber balloon. All of these materials for various reasons proved unsuitable. Recently, Wilson and Baker,[3] recognizing the need for a relatively simple



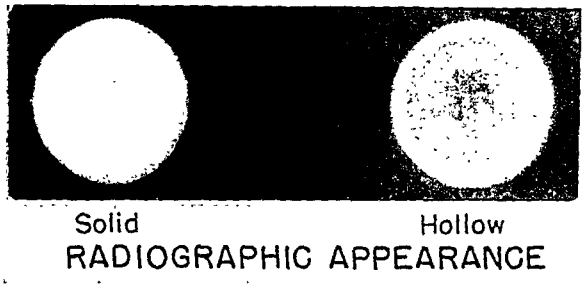


FIG. 1. Photographic and roentgenographic appearance of the methyl methacrylate (lucite) spheres.

FIG. 2. (below) Roentgenograms taken (*A*) before and (*B*) after solid lucite sphere procedures.



* From the Department of Radiology, Duke University School of Medicine and Duke Hospital, Durham, N. C.
† Trainee, National Cancer Institute.

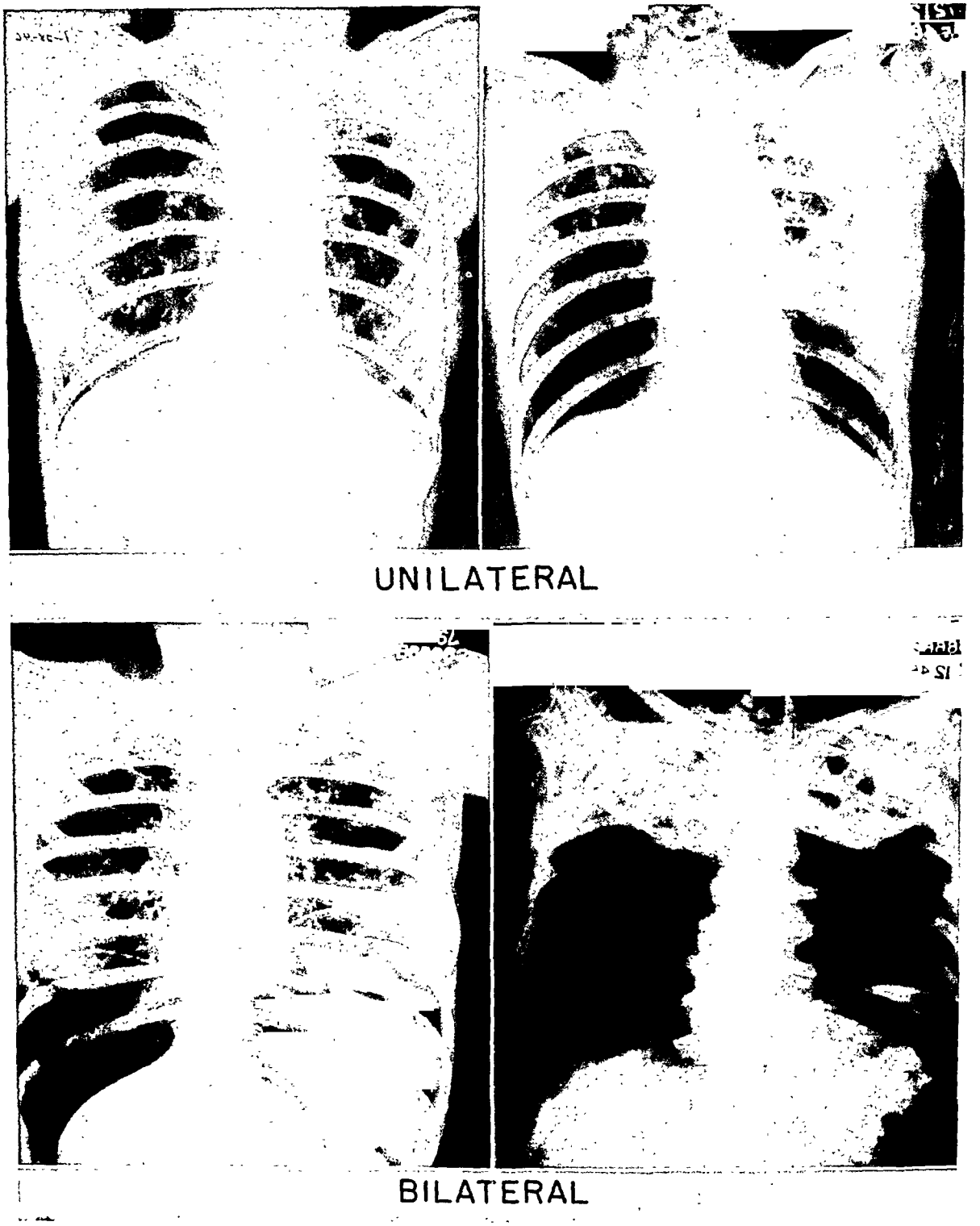


Fig. 3. Roentgenograms before and after (top) unilateral and (bottom) bilateral extrapleural apicolysis and hollow lucite sphere plombage.

procedure which could be used in the treatment of pulmonary tuberculosis in poor risk and complicated cases, found that methyl methacrylate, commonly known as "lucite," was a material that appeared suitable in experimental studies for the maintenance of pulmonary collapse in extrapleural pneumolysis procedures.

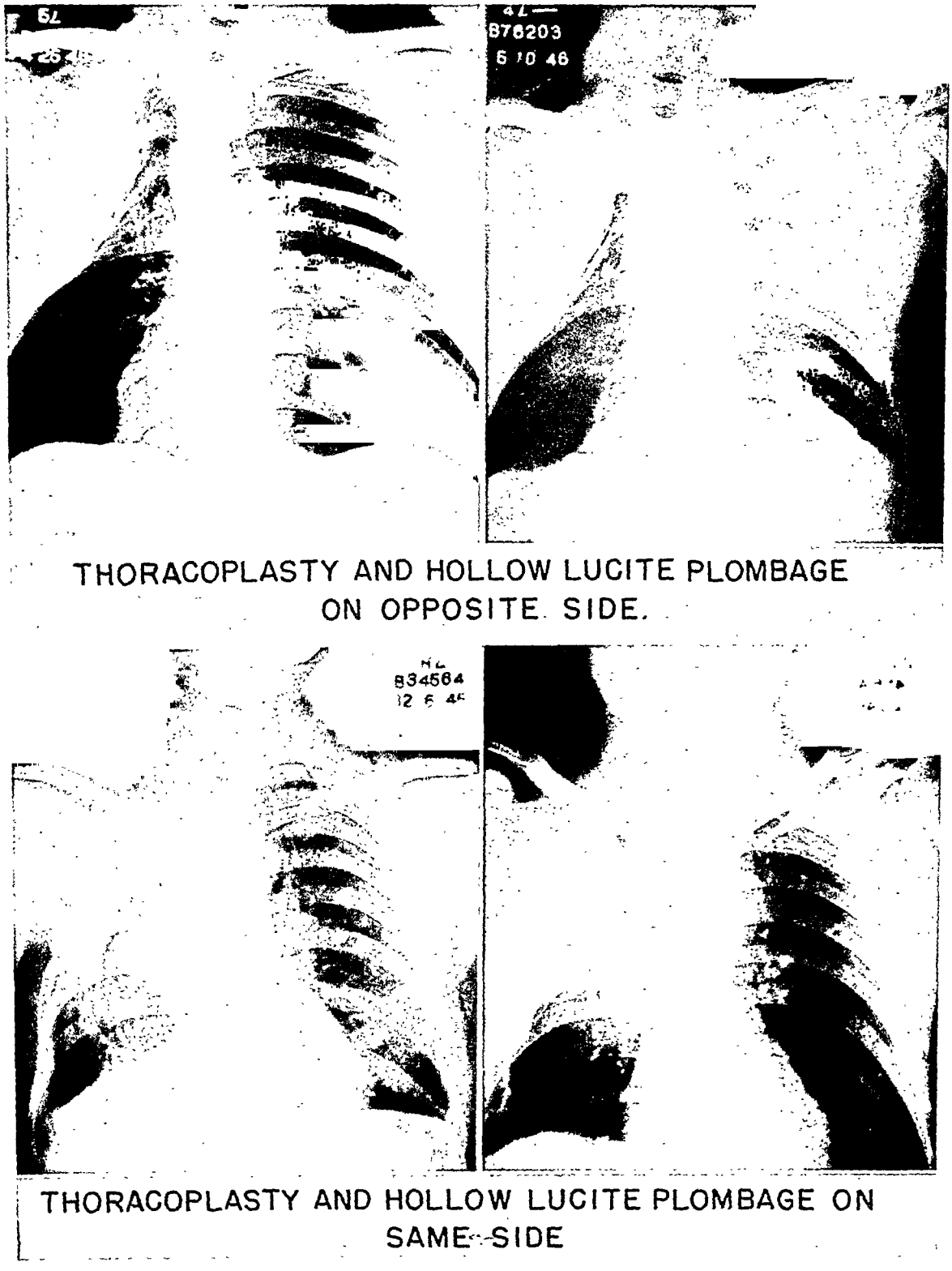


Fig. 4. Roentgenograms before and after (top) thoracoplasty and hollow lucite plombage on opposite sides, and (bottom) thoracoplasty and hollow lucite plombage on same side.

The extrapleural pneumolysis procedure utilizing lucite spheres as packing material has been in use in this clinic in conjunction with the various state tuberculosis sana-



Fig. 5. Cavity visualized on plain roentgenogram following lucite sphere plombage. Note elliptical contour of cavity and spherical appearance of lucite balls.

toria for the surgical treatment of pulmonary tuberculosis during the past nineteen months. McCain and McCain[1] have recently summarized the results obtained in 31 patients.

It is the purpose of this paper to present only the roentgenographic aspects of this procedure, and to emphasize the use of body section roentgenography in the subsequent studies following the lucite plombage.

The lucite spheres are of two varieties. At first, solid spheres were used in the procedure, but these have since been discarded because of weight. Hollow spheres, made by utilizing a lucite solvent to cement two half spheres, have been found to be more satisfactory, and are now used. The solid spheres have a density approximating tissue or fluid, and cast a dense shadow on the roentgenogram. The hollow spheres containing air cast a distinctive ring-like shadow, and this is easily recognized on the roentgenogram (Fig. 1).

In cases in which the solid spheres were used, the roentgenograms revealed an almost homogeneous density caused by the accumulation of a small amount of fluid and fibrous adhesions about the spheres as shown in Figure 2.

The procedure has been used both unilaterally and bilaterally. In Figure 3 examples of each are seen in which hollow spheres were used. The distinctive ring-like shadows of the hollow spheres are, of course, superimposed upon each other, but the characteristic pattern is readily recognized.

Extrapleural apicolysis and lucite plombage has been performed in conjunction and in combination with the usual thoracoplasty as is shown in Figure 4.

In all cases complete collapse and obliteration of the cavities has not been obtained. The procedure will displace and compress the original cavity so that its exact size and location may be obscure in subsequent study of the case. The confusing appearance of the ring-like shadows of the hollow spheres simulating multiple cavities add to the problem of roentgenographic interpretation, but the use of body section roentgenography in the subsequent studies of these cases has been of inestimable value. Occasionally a plain roentgenogram will reveal a cavity in which the size and shape of the cavity is entirely unlike that of the hollow lucite spheres (Fig. 5), but usually planigrams are necessary to demonstrate the residual cavity (Fig. 6).

An interesting series of roentgenograms is shown in Figure 7. In this case a lucite sphere plombage was done. Following the procedure the patient improved symptomatically, but the sputum remained positive. Planigraphic study revealed the cavity as shown in Figure 7*C*, and roentgenograms following subsequent insertion of more lucite spheres reveal the cavity to be obliterated.

DISCUSSION

Extrapleural pneumolysis is a relatively simple procedure which can be used in the surgical treatment of pulmonary tuber-

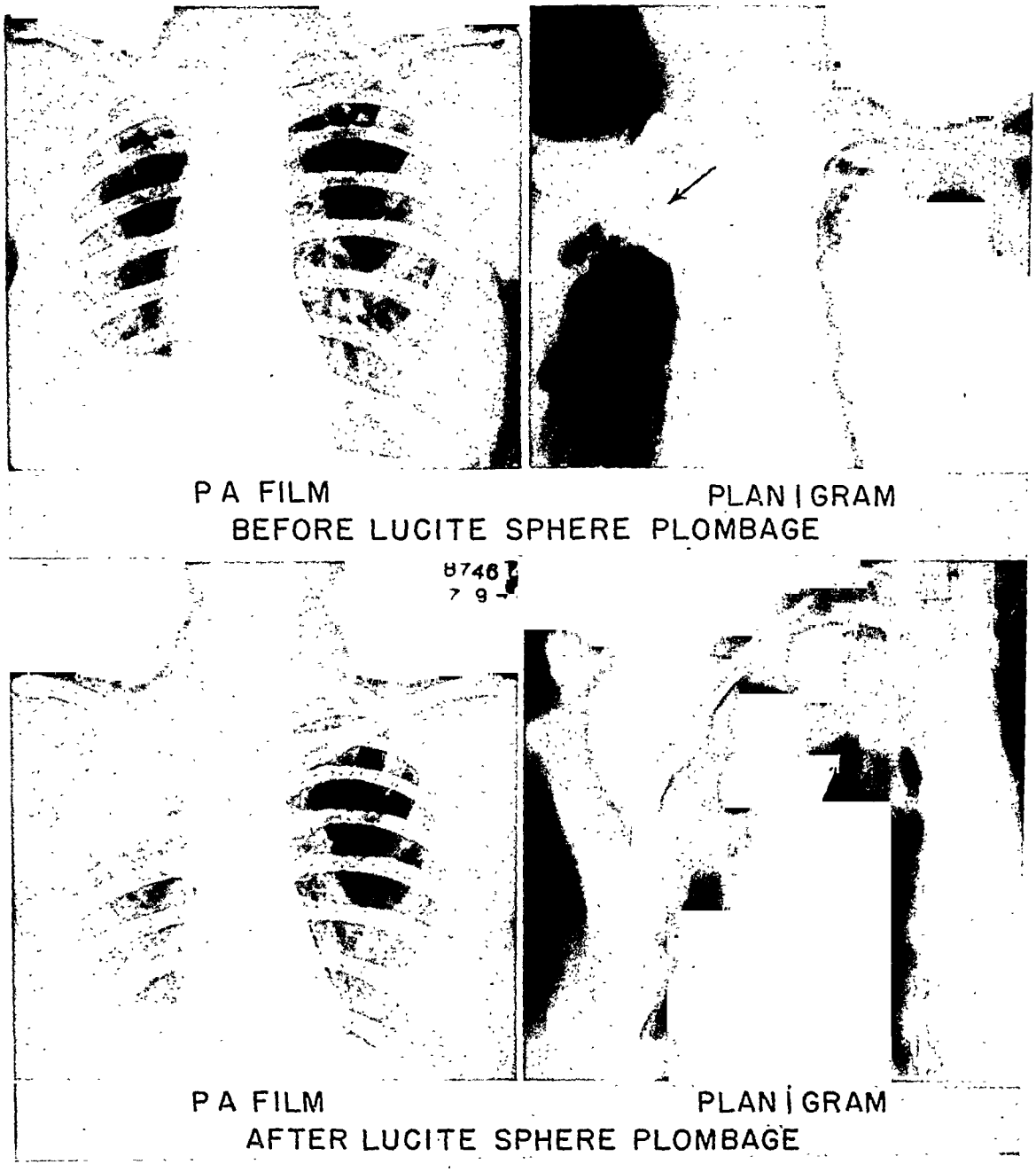


FIG. 6. Roentgenograms demonstrating cavity remaining after lucite sphere plombage (demonstrated only by planigram). The upper photographs show a plain film and a planigram before operation. The lower films taken after operation reveal the characteristic shadows of the lucite spheres with no definite cavity demonstrated on the plain film, and the cavity easily shown on planigraphic study.

culosis in poor risk and complicated cases, but which has fallen into disuse because of failure to find a suitable material that could be utilized for plombage. Methyl methacrylate (lucite) was found in experimental studies to be non-irritating, light, readily available, and well tolerated. It was apparently suitable for plombage, and has been given a clinical trial. The material has been used in the form of hollow spheres which are packed into the extrapleural space developed by apicolysis, and cast distinctive shadows on the roentgenograms. The procedure has been used unilaterally,

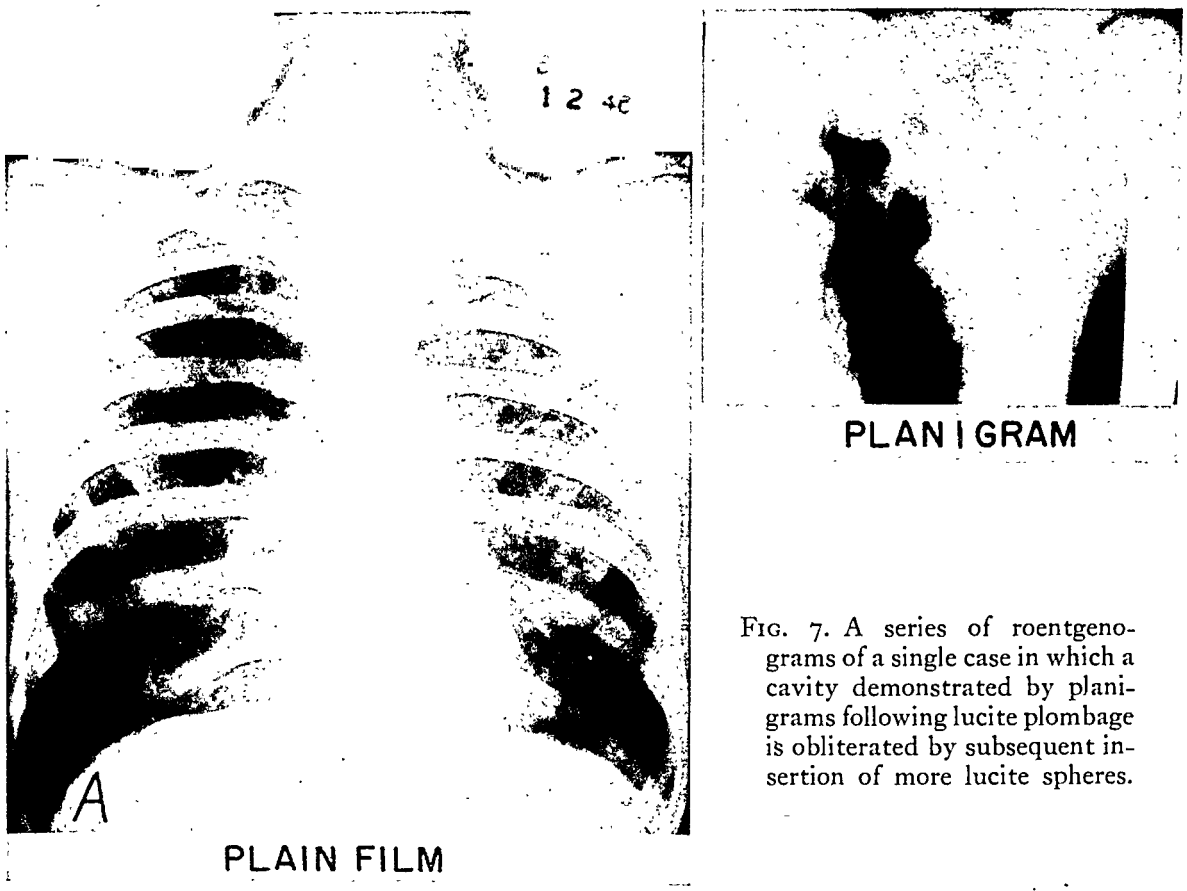


FIG. 7. A series of roentgenograms of a single case in which a cavity demonstrated by planigrams following lucite plombage is obliterated by subsequent insertion of more lucite spheres.

The films in (*A*) taken before operation show the lesion easily demonstrated by both plain film and by planigram. The roentgenograms in (*B*) following initial lucite plombage show the cavity only on planigrams. Note how the cavity (arrow) is compressed medially by the lucite spheres. The roentgenograms in (*C*) following subsequent insertion of more lucite spheres fail to demonstrate any evidence of cavitation either by plain film or planigrams.

bilaterally, and in combination or in conjunction with thoracoplasty. In all cases complete collapse and obliteration of cavities is not obtained, and because the hollow spheres which simulate multiple cavities make the demonstration of residual cavities by plain roentgenograms difficult, it has been found that planigraphy is of great value in the subsequent study of these cases.

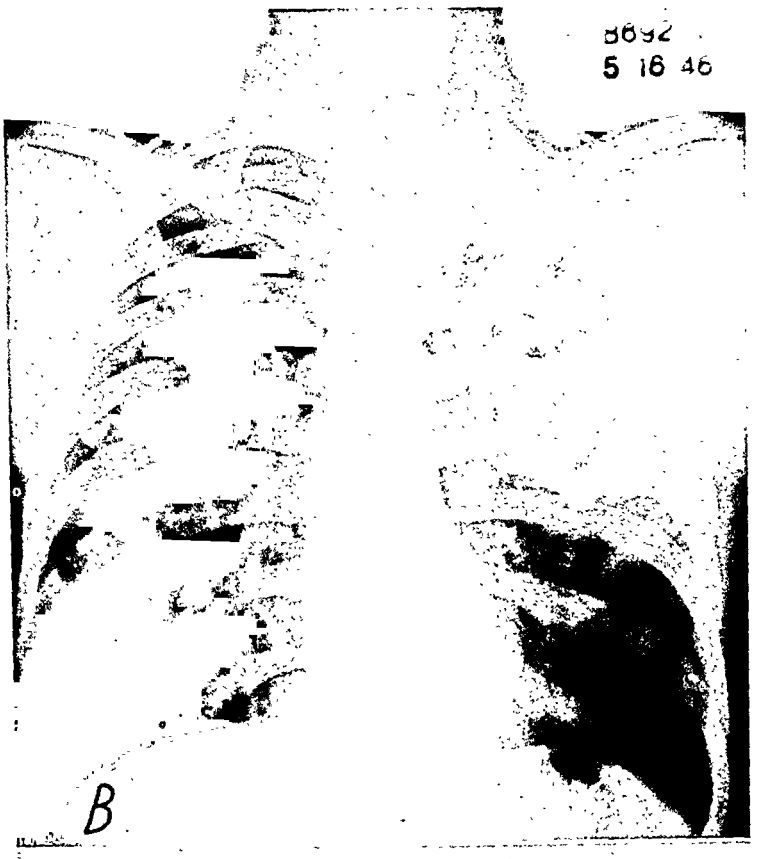
SUMMARY

The roentgenographic aspects of a series of cases of pulmonary tuberculosis in which extrapleural pneumolysis procedures utilizing methyl methacrylate (lucite) spheres for the maintenance of collapse has been presented. Particular attention to the value of body section roentgenography in the subsequent study of these cases is emphasized.

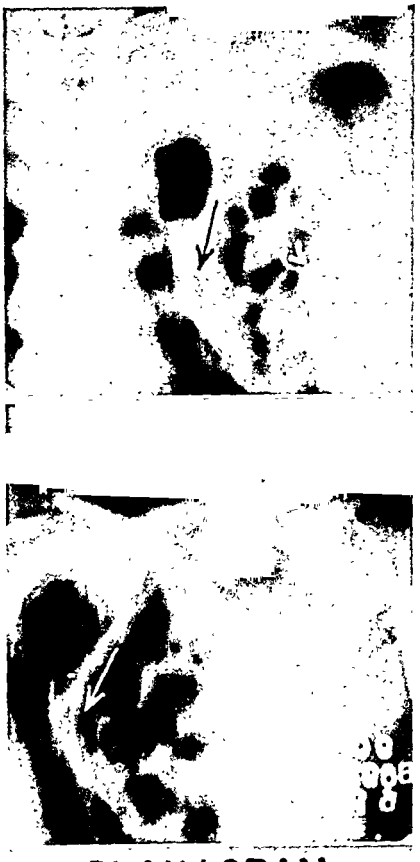
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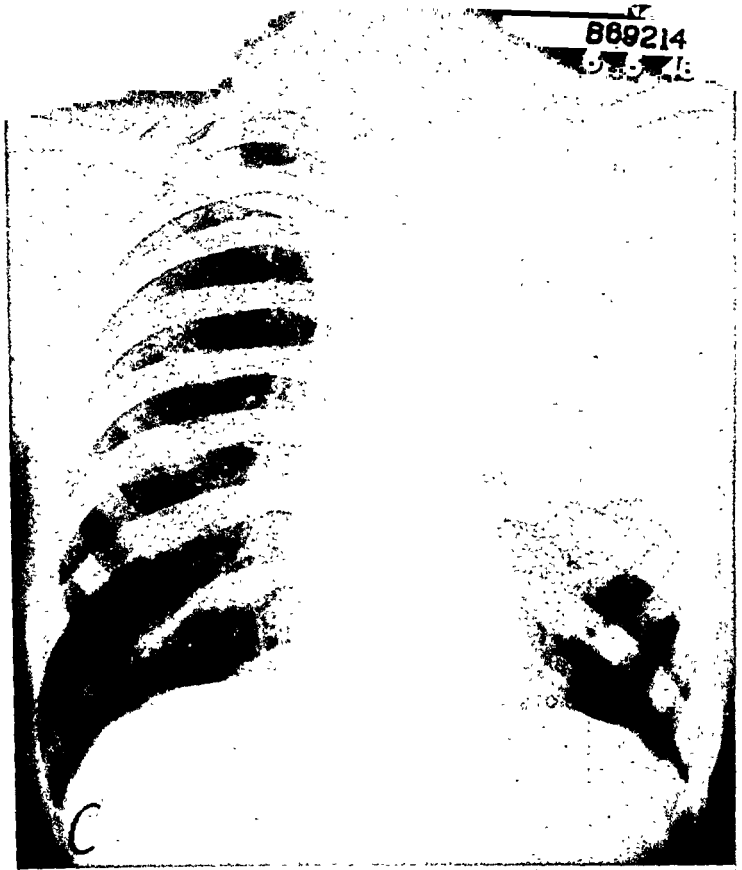
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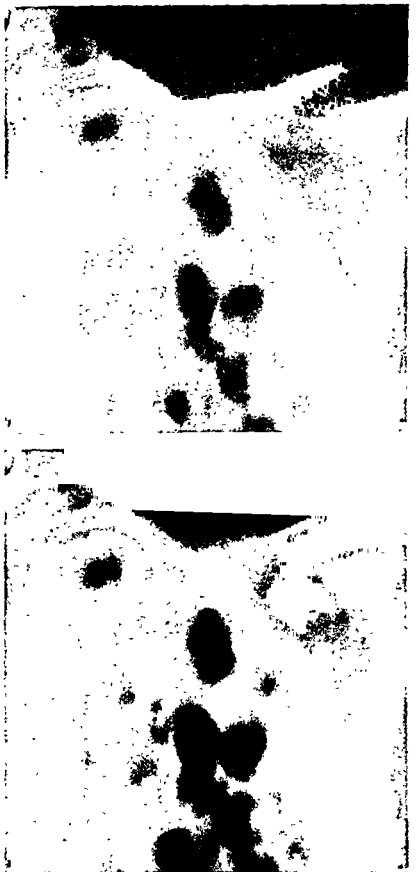
PLAIN FILM



PLANIGRAM



PLAIN FILM



PLANIGRAM

PRIMARY CANCER OF THE LUNG WITH SPECIAL REFERENCE TO APICAL LUNG TUMORS*

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THE similarity of the symptoms, physical signs, and of the roentgenographic findings in cases of primary cancer occurring at the apex of the lungs is a striking feature of the disease. This is in sharp contrast to the cases occurring at or near the hilum in which the onset of the disease may simulate numerous other conditions.

Tobias, in 1932, very ably described the syndrome produced by apical lung tumors as follows: "The painful apico-costo-vertebral syndrome is a symptomatic entity which establishes the existence of a process of neoplastic nature, and the syndrome helps to establish the early diagnosis of primary carcinoma of the lung." If Tobias had qualified his statement with the remark that, on occasion, other primary or metastatic tumors situated in the extreme apex of the lung might produce similar symptoms purely because of the anatomical location, his description would have been most complete.

It is amazing that although Hare in 1838 probably reported the first so-called superior pulmonary sulcus tumor it was not until 1924 and again in 1932 that further attention was directed to apical lung tumors by Pancoast. In 1924 he reported 4 cases of tumors occurring in the region between the root of the neck and the apex of the lung in which there occurred a peculiar clinical syndrome resulting from involvement of the brachial plexus and of the cervical sympathetic chain. This consisted of pain around the shoulder and down the inner side of the forearm of the affected upper extremity, atrophy of the muscles of the hand, and Horner's syndrome, namely, unilateral miosis, ptosis of the upper eyelid, enophthalmos and anhidrosis of the face and neck. In 1932 Pancoast added 3 new cases and republished the original cases. In this paper he stated that he believed the tumors arose from embryonal rests in the fifth pharyngeal pouch.

Pancoast designated these rumors as superior pulmonary sulcus tumors in that he believed a specific new clinical entity had been found. He further noted certain features which could be recognized roentgenographically, such as the presence of a sharply defined shadow at the apex of the lung, destruction of one or more of the upper three ribs posteriorly, and some erosion of the transverse processes and bodies of the corresponding vertebrae. There were no postmortem examinations made and in only 2 cases was biopsy material available for histopathological study. He stated that primary lung cancer could practically be ruled out. Although Pancoast's observations were incorrect as to etiology, he deserves great credit for stimulating interest in the study of apical lung tumors.

A typical patient with apical lung tumor presents the following symptoms and findings: A male about forty-six years of age with a presenting complaint of shoulder girdle pain of increasing severity of approximately six to eight months' duration. Later the pain radiates down the inner side of the arm into the ring and little finger of the hand. He becomes emaciated as a result of rapid weight loss and the severe pain. He walks with drooping of the affected shoulder and carries the affected arm in a more or less fixed position close to the chest with the elbow slightly flexed. The upper eyelid becomes ptosed and there is an absence of perspiration over one-half of the face and head. Cough is generally absent. His face reflects the agony of one who has suffered a great deal. Physical exami-

* From the Los Angeles Tumor Institute. Presented at the Second Inter-American Congress of Radiology, Havana, Cuba, Nov. 17–22, 1946.

nation reveals a Horner's syndrome on the affected side. There is atrophy of the muscles of arm, forearm, and hand. A mass can be palpated in the neck above the clavicle on careful examination. There is dullness to percussion over the extreme apex of the lung and diminution of the breath sounds on auscultation.

Roentgen examination reveals a well defined homogeneous shadow of increased density situated in the extreme apical portion of the lung. There is slight indentation and displacement of the trachea to the opposite side. Laboratory examination: Nothing remarkable. Clinical course rapidly retrogressive. Average length of life from onset to death approximately thirteen months.

In 1942,[11] I reported 12 new cases of tumors occurring in the region of the pulmonary apex and republished data regarding 15 previously reported cases, making a total of 27 cases observed during a six year period. Twenty-six of the cases were considered to be primary in the terminal bronchioles of the lung and 1 was metastatic to the pulmonary apex from an osteogenic sarcoma of the left femur. Histopathological data from biopsy or postmortem examination were obtained in 21 of the cases. The average age was 46.3 years. Cases have been reported from thirty years of age to the age of seventy-five. More than 95 per cent of the cases occur in men. The average duration of symptoms from onset to death was thirteen months. In the first 15 cases the diagnosis prior to admission was as follows: Tuberculosis in 4; tumor in 5; neuritis in 4; psychoneurosis in 1, and in 1 case no diagnosis was given. Cases have been reported who had tonsillectomies performed because it was thought that the shoulder pain was rheumatoid in origin. No evidence to substantiate a bronchiogenic origin has been observed by me or noted from reports in the literature.

One should be extremely cautious in procrastinating over the results of a series of only 2 or 3 cases. Only by a study of large numbers of cases of a single disease can we accurately gain knowledge of the life history of a disease and of the many variations present. For example, 1 case in this series lived for a period of thirty-two months and another for twenty-nine months, and so on; whereas the average for the whole series was only thirteen months, which corresponds with the figures given in many case reports. It would be easy to credit whatever treatment was given as causing the increased longevity if only a few cases were seen.

Symptoms are not produced as early in this type of lung cancer because obstructive bronchial changes such as is caused by the centrally located lung cancer do not occur. Also cough, hemoptysis and sepsis are unusual. Intrathoracic metastasis occurs but rarely. Hoarseness has been reported as a prominent feature by some authors.

Horner's Syndrome. Horner's syndrome is not essential for the diagnosis of a so-called superior pulmonary sulcus tumor. This syndrome depends entirely upon involvement of the cervical sympathetics. This may occur at any time. We have observed some patients for many months before Horner's syndrome became apparent. Its presence is a definite surgical contraindication.

Costal and Vertebral Changes. Costal and vertebral changes are not essential for the diagnosis since the time of their appearance is also variable and in the case of a benign neurofibroma it might never occur. When the costal and vertebral changes do occur, there is generally both a pressure necrosis and malignant infiltration of the bony structures about the tumors.

Shoulder Girdle Pain. Severe shoulder girdle pain generally means involvement of the brachial plexus and therefore complete surgical extirpation of the lesion is impossible. Pain is almost always the first symptom of the disease and is both superficial and deep in character. It may begin in the posterior shoulder region, the anterior shoulder region or in the axilla or arm. It is generally referred to as a gnawing, knife-like or boring pain.

TREATMENT

Surgery. The complete removal of these tumors must take place before extension into the mediastinum or brachial plexus has occurred. This automatically restricts surgery to a very few of the tumors. Recently, while serving on active duty in the United States Navy, I had occasion to follow the course of 2 patients which serves to emphasize early surgery and of early investigation of the apical region in patients who have shoulder girdle pain. One of the patients was thirty-seven years of age. Some years previously, he had been told that he had a tumor in the left apex, the nature of which was not determined at that time. He had shoulder girdle pain which was mild and not constant. More recently the pain had become quite severe and he developed a Horner's syndrome and destructive changes in the second and third ribs posteriorly and adjacent portions of the vertebrae. At surgical exploration it was impossible to remove the tumor and a biopsy revealed it to be a neurogenic sarcoma. Coincidentally, a twenty-three year old premedical student who was a seaman in the Navy was a patient in the hospital at the time because of shoulder girdle pain and the presence of a dense homogeneous shadow at the apical portion of the lung. Horner's syndrome and costovertebral changes were not noted. Since he had watched the operation on the previously described patient, he readly consented to surgery and a neurofibroma was removed in its entirety. Had the first patient consented some time before to surgery, he would have been cured.

Irradiation. Radiation therapy has been disappointing. The tumors are radioresistant and are not complicated by secondary infections as compared with cancer of the lung in general, where definite palliative results may be obtained by irradiation. Cases have been presented where there has been regression of the tumor and some diminution in the pain only to recur a short time later. Some of the cases reported in the literature as responding to irradiation were not followed long enough for an adequate study. Several of my patients living the longest periods of time had obtained no regression of their tumors or diminution of the pain following irradiation. Some of the patients received very large total doses without benefit. Irradiation should be prescribed for every patient who is not operable, to give the patient the benefit of the doubt. External irradiation followed by the implantation of radon seeds was also tried without appreciable prolonged benefit.

Special Procedures. (1) Paravertebral alcohol injections have been tried without much benefit. (2) Chordotomy is a hazardous procedure and the results may be unsatisfactory. (3) Multiple posterior root section will produce a useless upper extremity but may give relief from the pain in some of the cases.

DISCUSSION

Metastatic lesions from the breast, kidney, adrenal, pancreas and from the stomach have been reported as causing this syndrome; also thymic tumors and intrathoracic sympathoblastoma.

The preponderance of evidence to date is that the great majority of malignant tumors in the region of the thoracic inlet or pulmonary apex are primary carcinomas arising in the terminal bronchioles of the lung.

The characteristic symptomatology of brachial plexus and cervical sympathetic involvement is a late manifestation of the disease.

The first symptom in practically all cases is shoulder girdle pain which sooner or later radiates down the arm. Patients having shoulder girdle pain should have a roentgenographic examination instead of being treated for rheumatism, arthritis, neuritis, bursitis, and so forth for months before adequate examinations are made.

In the presence of a primary tumor in the apex without Horner's syndrome or apparent brachial plexus involvement, a sur-

gical investigation should be done. Neurofibromas or other benign lesions and possibly very early primary cancers of the lung could then be adequately removed.

With regard to primary cancer of the lung in general there has been a real as well as a relative increase. The lung ranks second only to the stomach as a primary site of cancer.

In the diagnosis of primary cancer of the lung the single most important diagnostic procedure is a roentgenographic examination of the chest. Although one should never attempt to diagnose cancer of the lung positively by roentgenographic examination alone, sufficient data can generally be obtained to warrant further study.

Bronchoscopy should be resorted to in order to obtain a specimen for histopathological study. Since approximately 85 per cent of primary lung cancers are situated at or near the hilum, it will be possible to make a positive diagnosis in a high percentage of cases by this method. In some of the more peripherally located tumors where biopsies cannot be made, valuable information, such as evidence of immobility, narrowing, and deformity of the bronchi will be obtained.

With regard to exploratory thoracotomy, if doubt exists concerning the question of operability, exploratory thoracotomy should be done. The mortality from this procedure is negligible. We have no hesitancy in performing exploratory laparotomies in cases of questionable intra-abdominal lesions. Without surgery the death rate is always 100 per cent in lung cancer.

Graham has not had a case presenting even a clear pleural effusion live longer than six months following pneumonectomy, and he is of the opinion that pleural effusion either bloody or clear probably contraindicates operation. Bloody pleural fluid is definitely a sign of inoperability.

In peripherally located tumors where it is difficult to obtain tissue for histopathological study, aspiration biopsy under roentgenoscopic control may be done. It is believed that the question of leaving tumor implants is more theoretical than practical. Occasionally this will be the only means by which a diagnosis can be made.

Total pneumonectomy is the only procedure which will adequately remove the primary lesion and the regional lymph nodes which drain that lesion. Ochsner and DeBakey found the incidence of metastasis to the regional lymph nodes in 3,047 collected cases of cancer of the lung to be 72.2 per cent. In a series of 100 autopsied cases which Joslin and I[12] reported in 1938, the evidence of metastasis to regional lymph nodes was 63 per cent. Lobectomy is certainly a totally inadequate procedure.

I am convinced that primary cancer of the lung is a surgical problem until inoperability is established. We must remember that it has been only thirteen years since Graham performed the first successful pneumonectomy for primary cancer of the lung and this patient is still living at the last report. Since that time numerous pneumonectomies have been done and the operative mortality is steadily decreasing in the hands of experienced chest surgeons. The early mortality has been high but constant improvement in technique and selection of cases has occurred. For example, Shenstone performed his first 4 pneumonectomies before 1938 and all proved fatal. Since 1938 he has reported 9 cases of total pneumonectomy for bronchiogenic cancer with only 2 deaths. Graham reported a series of 75 total pneumonectomies, in which 70 were for carcinoma. There were 20 deaths in the hospital, or a mortality of 30 per cent. In the last 25 cases, there were only 3 deaths, or a mortality of 12 per cent. Rienhoff reported a series of 71 total pneumonectomies for primary cancer of the lung in which there were 15 deaths in the hospital, or a mortality of 21 per cent. There was a succession of 17 cases in his series in which there were no deaths. From the above figures, it can be seen that much of the prevailing pessimism regarding surgery is not justified. We have only to compare these

figures with those for colon and gastric surgery and then we must realize that chest surgery for cancer of the lung is in its infancy. With the use of the newer drugs and with the establishment of chest centers over the country, the technique of the operation will continue to improve resulting in a further reduction in the mortality rate.

For the inoperable cases of primary lung cancer, radiation therapy is of definite palliative value. Radiation therapy reduces the inflammatory complications produced by the bronchostenosis thereby resulting in general clinical improvement of the patient. The average duration of life in a group of 66 treated cases where it could be accurately determined was 15.2 months. Forty-eight cases in which the average duration of life could be ascertained, and who received only symptomatic treatment, lived for only 8.7 months.[12] Many additional cases have been observed since this study with similar results. If very large total doses of radiation are given in an attempt to destroy the lesion, we have found that the pneumonitis and the resulting fibrosis probably hasten the final outcome. The routine use of radiation therapy is advocated for all inoperable cases.

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ESOPHAGEAL HIATUS HERNIA WITH INVERSION OF THE STOMACH

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HERNIAS through the diaphragm continue to present interesting and occasionally unusual problems. The more common types have come to be well recognized during the past twenty-five years, and the steadily increasing frequency of rotengen examination has shown them to be present in relatively large numbers. They have been found in patients with a wide variety of symptoms, and it has been shown that there is no constant relationship between the size of the hernia and the magnitude of the symptoms. The previously existing divergence of opinion as to what proportion of cases should be subjected to surgery for repair has gradually disappeared as the results of surgery have been improved.

The recent rapid strides in thoracic surgery with the short period of hospitalization and the early return to normal function make it imperative that we become familiar with even the more infrequent types of diaphragmatic hernia. Such familiarity would permit adequate repair during a period of election and thus avoid the high mortality of emergency surgery during a period of shock.

A case of inversion of the stomach within a hiatus hernia was reported by me in 1937[3] but the potential danger of the inversion was not appreciated at that time. The patient had had symptoms for about six years, and at the time of our examination the fundus of the stomach was in the abdomen although its antrum was in the left chest. Both portions of the stomach were greatly dilated and there was a forty-eight hour residue in spite of aspiration. The unusual position of the stomach was interpreted as indicating that the hernial orifice was lateral to the hiatus esophageus, but at operation it was shown that this was not true. The hernia was actually through the hiatus esophageus which was normally placed but greatly dilated. It was then learned that roentgen examination done about five years earlier had shown only the fundus of the stomach involved in the hernia. It appears, therefore, that inversion of the stomach occurred at some time after the hernia had become manifest.

In that same year Bowen[1] reported a somewhat similar case in a male, aged forty, who had had recurrent attacks of pain in the left chest, dyspnea and vomiting over a period of eight years. Roentgen examination had shown a rather large hernia with the stomach and a portion of the transverse colon in the chest. The patient died about forty-four hours after the onset of an acute attack, and autopsy showed that the stomach was twisted upon itself with constriction at both the cardia and pylorus. The position of the pylorus was higher than that of the cardia and the stomach contained 4 quarts of blood-stained fluid. Portions of the colon and omentum were also in the left chest.

Two additional cases were reported in 1944. One[2] was of a woman, aged fifty-seven, who had been known to have a hiatus hernia for at least four years. She was hospitalized because of acute pain in the left chest accompanied by ineffectual attempts at vomiting. At operation the hernia was reduced and immediately thereafter the stomach was seen to turn from right to left. It was distended to a measurement of about 9 by 20 inches. Sutures were placed in the hiatus and she made a complete recovery. The other case[4] was of a woman, aged sixty-six, who had been thought to have a hiatus hernia of the usual type for about two and a half years. She was seen about three days after the onset of an acute

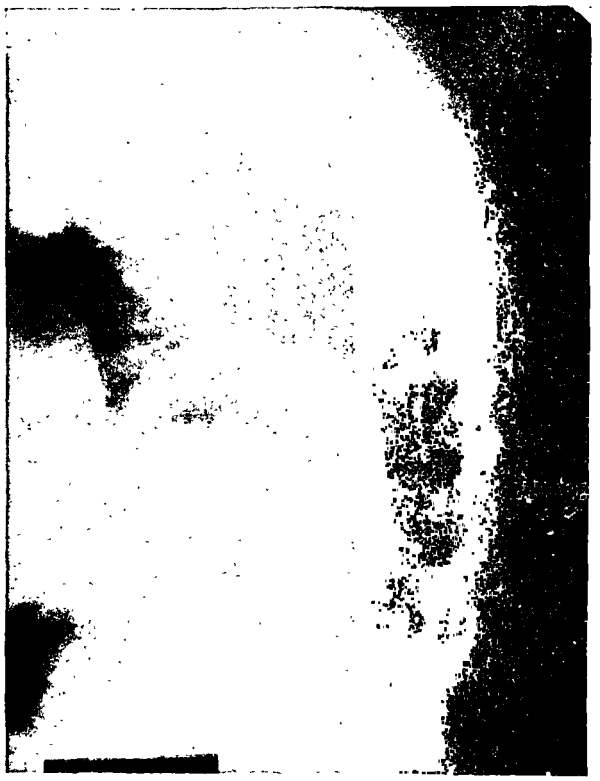


Fig. 1. Case 1. Lateral view of the spine taken elsewhere about eighteen months before the terminal episode. Note the gas bubbles above and below the diaphragm.

attack in a drowsy and uncooperative state. There was eccentric convexity in the left upper quadrant of the abdomen and the stomach was found to contain 3,100 cc. of fluid. Roentgen examination on the following day showed the fundus of the stomach below the diaphragm and the antrum above it. The duodenum was obstructed. Operation was done two days later and she was subsequently discharged, free of difficulty.

We wish to report 2 additional cases of inversion of the stomach within a hiatus hernia.

Case 1 (NEDH 119,035). A housewife, aged fifty-six, was first seen as an office patient by Dr. F. W. Marlowe on January 11, 1943, because of backache. The backache had been present for about two years and had been associated with cramps in her legs. She believed that her appetite was good but stated that she was troubled with "gas after meals." Physical examination at that time was negative except for evidence of arteriosclerosis and an exaggeration of the normal thoracic and lumbar curvatures. Roentgen examination of the spine was made at that time at another hospital. That examination showed evidence of osteoporosis. A diagnosis of hiatus hernia was also made because of a rather large gas bubble which was seen behind the heart. A high calcium diet was prescribed together with supplementary vitamins. She was seen on several occasions during the next few months but there were no new symptoms or changes in the physical examination.

During the summer of 1944 she had a few osteopathic treatments against the advice of her physician. One such treatment was given during the evening of August 17, following a hearty meal, and in spite of some nausea which had followed the meal. She was wakened from sleep during the night and called her physician because of nausea with pain in the region of the left costal border. She was seen at 3:30 A.M. sitting erect in bed. She complained of some dizziness and stated that the pain was worse if she attempted to lie down. Examination showed a temperature of 97° F. with pulse of 100 and blood pressure of 160/100. Heart



Fig. 2. Case 1. Supine roentgenogram showing the large mass which contained both fluid and gas.

sounds were of rather poor quality but no murmurs were heard. There was a sense of resistance in the left upper quadrant of the abdomen but no definite mass was felt. Immediate hospitalization was advised but was refused. She was given 15 mg. of morphine for relief of pain. When seen six hours later she seemed somewhat more comfortable but examination then showed a definite mass in the left upper quadrant. Temperature was normal, pulse was unchanged and the total white blood cell count was 10,500. Hospitalization was again refused. Further medication was withheld in the hope that she would soon consent to be moved. This she did late in the evening of the same day. At the time of admission to the hospital the mass filled the epigastrium and left hypogastrium and was so firm that it was difficult to define the costal margin. There had been no vomiting or diarrhea.

On the morning of August 19 the mass was even larger, the patient was slightly cyanotic and the pulse was of rather poor quality. Roentgen examination then showed the mass in the left side of the abdomen which extended down to the level of the iliac crest. A second, smaller mass was shown behind the heart, and upright roentgenograms showed a fluid level within each



Fig. 3. Case 1. Erect roentgenogram showing fluid levels above and below the diaphragm.



Fig. 4. Case 1. Supine roentgenogram after ingestion of small amount of barium. The large abdominal mass is now shown to be the greatly dilated cardiac end of the stomach. The antrum of the stomach is in the left chest posteriorly and displaces the esophagus to the right.

mass. One fluid level was situated posteriorly at the level of the ninth thoracic vertebra and the other anteriorly at the level of the eleventh thoracic vertebra. The left diaphragm was poorly shown but it was believed to lie between the two fluid levels. It was also believed that both fluid levels were within a greatly dilated stomach and that the dilatation was the result of inversion within a hernial sac. A small amount of barium by mouth confirmed these impressions. The esophagus was displaced slightly toward the right by the mass behind the heart and was narrowed as it passed through the diaphragm. It emptied into the distended portion of the stomach which lay in the abdomen.

Patient was operated upon by Dr. Leland S. McKittrick. About 4 liters of fluid and undigested food particles was removed from the stomach through a trocar. Following this, the hernia was easily reduced by gentle traction. The hernial orifice admitted three fingers easily and did not constrict the stomach after the abdominal loculus was emptied. Repair was not attempted because of the poor condition of the



FIG. 5. Case II. The inversion of the stomach is similar to that of Case I except for the absence of severe dilatation.

patient. Respiratory embarrassment was temporarily relieved following operation, but she continued to be in a state of shock in spite of measures to combat it and died at 10:30 A.M. on August 20.

CASE II (PMH 46:1540). A married woman, aged forty-nine, was admitted to the hospital on October 23, 1946, because of pain beneath the left costal margin. This pain had been first noted about one year before and usually came on after meals. During the first few months it had been partially relieved by belching. Roentgen examination made elsewhere about one month after onset of symptoms was said to have shown a diaphragmatic hernia.* Vomiting was first noted about seven months before admission but had disappeared during a two week period of medical treatment in another hospital. About ten days before admission to the Deaconess Hospital the vomiting recurred, was very forceful and was not related to meals. She had taken no food by mouth during this period but had been maintained in satisfactory chemical balance by intravenous fluids.

* We have been permitted to see these roentgenograms and have found them to be identical with our own.

Roentgenoscopic examinations in the upright position showed a large gas bubble behind the heart and a much smaller one beneath the left diaphragm. Unfortunately an upright roentgenogram was not taken for record of these collections of gas. Barium was given by mouth and showed the esophagus to be of normal length and emptying into the stomach just below the diaphragm. Approximately one-third of the cardiac end of the stomach was in this position but the major portion of the stomach was above the diaphragm and behind the heart. Its greater curvature was uppermost but its contour was smooth, and feeble peristaltic waves were seen. The pylorus and duodenal cap were just to the left of the midline and immediately below the diaphragm. The second portion of the duodenum was normally placed.

Transthoracic operation was done by Dr. Richard H. Sweet. More than half of the stomach and much of the omentum were found within the hernial sac which was adherent to the other tissues of the mediastinum. The hernia was reduced, the sac removed and the defect closed with silk sutures. The patient was discharged, free from symptoms, on the eighteenth postoperative day.

We very much regret the fatal outcome of the first case since it now appears quite probable that a favorable outcome might have been obtained had the patient been willing to accept hospitalization at an earlier time. It is of particular interest that the roentgenograms of the spine which had been taken eighteen months prior to the acute episode had shown gas bubbles both above and below the diaphragm, although only the one above the diaphragm had been noted. Our own experience and a rather careful search of the literature have failed to show a single case of hiatus hernia of the usual type in which more than one gas bubble was present. In hernias which involve only a relatively small portion of the fundus of the stomach the single gas bubble, if present, is found below the diaphragm. In those which involve larger portions of the cardiac end of the stomach, and especially if adhesions are present about the hiatus, the single gas bubble is frequently found above the diaphragm. It is usually on the

left side and behind the heart, but may occasionally be on the right side.

It thus appears that inversion of the stomach should be seriously considered whenever the double gas bubble is found, and even before barium is given. If such a condition is suspected, early confirmation by barium studies should be strongly urged. If inversion is shown to be present, surgical repair should be undertaken very soon in the hope of avoiding the unfortunate sequence of strangulation and acute dilatation of the stomach.

Occasional cases of hiatus hernia may also be seen in which there is rotation of the stomach through an axis in the coronal plane, but in which the fundus remains above the diaphragm and the antrum below it. The 2 following cases are representative of this type of rotation:

CASE III (PMH 46:1517). A married woman, aged seventy, was admitted to the hospital on October 20, 1946, under the care of Dr. Allen G. Brailey. Her complaints were of weakness, unsteadiness of gait and pain in her legs. These symptoms had had their onset about one year before and had gradually become more severe. There was no weakness or paresthesia of the upper extremities. She had occasionally had some substernal pain with effort, but this pain did not radiate and was relieved by nitroglycerine.

Significant features in the physical examination included the following: pale skin and mucous membranes; blood pressure of 210 systolic and 115 diastolic without cardiac murmurs; absent knee jerks, ankle jerks and plantar reflexes; and positive Romberg test.

Laboratory studies showed 4,190,000 red blood cells and 8,350 white blood cells per cubic millimeter, with 10 grams hemoglobin per 100 cc. Differential white blood cell count was normal except for 7 per cent eosinophils. Gastric analysis showed free hydrochloric acid as high as 45 units in one specimen, with occult blood in all specimens.

A consultant is neurology believed that there was evidence of damage in the posterior columns of the spinal cord and that this was probably due to the hypertension, arteriosclerosis and secondary anemia. He believed that the treatment was that of the anemia.



FIG. 6. Case III. The entire stomach is within the hernial sac and the greater curvature is uppermost.

Roentgen examination of the chest was done as a routine procedure and showed no abnormality of the heart or lungs. An oval area of radiolucence was easily seen behind the heart and measured about 9 by 11 cm. This shadow was assumed to represent a gas bubble in the stomach within a hiatus hernia and subsequent studies with barium by mouth confirmed this, as indicated in Figure 6. A gas bubble was not shown in the portion of the stomach below the diaphragm. Barium enema showed that the colon was not involved in the hernia.

Because of her age and poor general condition it was deemed unwise to operate on this patient. She has improved slightly on a medical regimen with added iron.

CASE IV (NEDH 135,212). A married woman, aged forty-four, was admitted to the hospital on November 26, 1946, because of "stomach trouble" of one and one-half years' duration. Her original symptom was that of epigastric pain which was made worse by eating. This distress had gradually become more severe and during the few months just prior to admission she had vomited two or three times each week. The vomiting usually occurred following the evening meal. She had lost approximately 40 pounds during her illness but physical examina-

tion was negative except for evidence of weight loss.

Roentgen examination showed a hiatus hernia with the position and contour of the stomach almost identical with the preceding case shown in Figure 6.

Operation was done through an abdominal incision by Dr. Bentley P. Colcock of the Lahey Clinic. All of the stomach except for a short segment of the pyloric antrum was found within the thorax together with a large portion of the omentum. The gallbladder was absent as a result of a previous operation but no other abnormality was noted. The hernia was easily reduced and the hiatus was sutured until it would admit only one finger. Removal of the appendix was also done. Convalescence was uneventful and the patient was discharged to her home on the eleventh postoperative day.

It is possible that the type of hernia seen in the last 2 cases represents a transition between the very common hiatus hernia which involves only the fundus of the stomach and the type first noted, in which there is a complete inversion of the stomach within the hernial sac. We have not had an opportunity to follow this sequence of events.

CONCLUSION

It is our belief that many hiatus hernias which involve only the fundus of the stomach do not give rise to symptoms or signs sufficient to warrant surgical repair. We believe, however, that when rotation of the stomach occurs within the hernial sac the indications for surgery are definitely increased, and that if actual inversion is present the danger of strangulation and acute dilatation is real.

Inversion of the stomach within a hiatus hernia should be strongly suspected if gas bubbles are seen both above and below the diaphragm in any roentgen examination of the lower thorax or upper abdomen.

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POUCH FORMATION FOLLOWING GASTRO-ENTEROSTOMY*

By LIEUTENANT COMMANDER ERNEST LANDY (MC) USNR

THE operation of gastroenterostomy has since its inception been the subject of much controversy concerning the indications for this procedure, especially in the light of the numerous poor results and complications that followed.

This is evidenced by the voluminous literature that has been written on the subject. My interest in this condition was due to persistence of symptoms in a group of patients that had gastroenterostomies for peptic ulcer done over a period of years with notable unimprovement of their symptoms and, in many, actual increase in their discomfort. This group had been hospitalized on numerous occasions at various hospitals. The operative procedures were done by different surgeons in various institutions for peptic ulcers.

These patients, in addition to recurrence of symptoms, had complications such as recurrent hemorrhages, new or recurrent ulcers, perforations and obstructive symptoms.

It is the purpose of this paper to present a phase of the problem which may have a bearing on the malfunctioning of the gastroenterostomy that was noted in these cases.

The causes that have been ascribed to the malfunctioning of a gastroenterostomy have been varied and numerous, some controversial. Indeed, as noted by Bevan, at operation an excellent gastroenterostomy stoma was found and no cause for the patients' symptoms or malfunction found. The question naturally arises whether there is a functional derangement preventing the gastroenterostomy from functioning properly.

Some of the factors responsible for poor results mentioned in the literature are as follows:

Faulty Preoperative Management or Selection of Cases:

Omitting to treat chronic duodenitis or gastritis especially when marked.
Failure to eradicate foci of infection.
Failure to correct blood chemistry deficiency such as alkalosis prior to operation.
Failure to aspirate, irrigate stomach and to use dietary measures in cases of dilatation of the stomach.
Must be definite indications for this operation. Gastroenterostomy functions best when there is obstruction at the pylorus.
Unnecessary operation in a patient with achlorhydria.

Errors in Operative Technique:

Improperly placed stoma.
Stoma too close to pylorus or too highly placed, or stoma too distant from pylorus in an atonic stomach.
Use of non-absorbable suture material acting as a foreign body.
Stoma too small.
Stoma too large forming a so-called "dumping" stomach by which food passes into jejunum, overloading it and causing a "gastrocolic reflex."
Too narrow an attachment at stoma permitting an acute angulation.
Pressure on middle colic artery.
Too large an area of bowel wall used in anastomosis making possible the formation of pouches (Finsterer).
Too short a jejunal loop causing a kink by binding stomach to spine.
Too large a proximal jejunal loop causing stasis, vomiting and regurgitation.
Opening made into distal pouch in case of hour-glass stomach with junction too short or incorrectly sutured.
Opening in mesocolon incorrectly placed, e.g., too close to colon.
Opening in mesocolon too small or left unsutured.
Stitching opening in mesocolon to jejunum or to the anastomosis and not to the stomach.
Suture edges not inverted.
Faulty suturing.

* From the U. S. Naval Hospital, Balboa, C.Z.

Anastomosis too tight.
Interrupted sutures used throughout.
Tying knots too large.
Sutures drawn too tightly.
Clamps applied too tightly.

Anatomical Factors:

Rigid and short mesocolon.
Obesity of patient.
Too high a fixation of the mescolon.

Pathological Conditions:

Swelling of mucosa about stoma with development of a jejunitis or stomal ulcer.
Pouching of gastric mucous membrane about stoma.
Gastrojejunal ulceration.
Gastric ulcer developing following operation.
Jejunogastric intussusception.
Pylorus again becoming functional following operation as a result of subsidence of edema and inflammatory swelling.
Volvulus of jejunal loop.
Pathological processes in stomach preventing it from emptying.
Recurrent ulcerations.
Internal herniations.
Adhesions about stoma.
Hematoma or hemorrhage about stoma.
Failure to excise, cauterize, or remove a chronic gastric or duodenal ulcer if present.
Failure to remove a septic intra-abdominal focus when present, such as a chronic appendicitis or a chronic gallbladder condition.
Duodenal ileus.
Faulty postoperative management.

Other Conditions that May Contribute to Malfunction:

Defective emptying time of stomach due to loss of muscle tone.
Deficiency in chymification and maceration.
Digestive deficiency from lack of enzymes.
Vitamin B deficiency.
Failure of stoma to develop sphincteric action causing so-called "gastroduodenal reflex" of Kelling; that is, food entering the duodenum fills it and prevents stomach from emptying.
Constitutional asthenia.
Age of patient.
Nervous intestinal hypermobility.
Late development of anemia.
Hypoproteinemia producing edema of stomach wall.
Unknown causes. At operation or postmortem excellently formed gastroenterostomy may be present yet with a poor functional result.
Poor motor function of stomach.

Following gastroenterostomy, obstruction at pylorus may become relieved due to the subsidence of edema and inflammatory reaction. After the operation symptoms in these cases may be improved, at first; however, later, the removal of the obstruction factors at the pylorus, a poor functioning of the gastroenterostomy may result.

In the following series of cases the patients had a gastroenterostomy performed for duodenal ulcer and without exception presented numerous symptoms over a period of years. Not only were the symptoms usually unrelieved by the operative procedure, but in addition they developed many new symptoms and were hospitalized on numerous occasions or were on medical treatment most of the time. The roentgen findings consisted of small pouches located about the stoma, or in some cases the pouches were formed by larger segments of the stomach wall. The latter apparently were due to spasm about the stomal site, by which the enterostomy opening apparently was "drawn up" toward the lesser curvature forming two large pouches of the stomach. The "local pouches," that is, the outpocketings surrounding the stoma tended to form on all sides of the opening. In the most marked cases noted, there was considerable obstruction at the site of the enterostomy opening, so that the barium could not pass through the stoma, although the barium went through the pylorus into the jejunal loop and apparently little could re-enter the stomach or pass through the efferent jejunal loop.

The location of the stomas in these cases varied, some were near the pylorus, some higher up on the greater curvature and some were in the most dependent portion of the stomach in the recumbent position.

The sites also varied with the position of the patient.

The pouch formation was not noted on all examinations and it was necessary to place the patient in various positions to demonstrate them, as they could be easily overlooked. The pouches also varied with the state of filling of the stomach. In some cases the pouches were outlined with a small amount of barium, and in others they were more pronounced with larger quantities of barium in the lumen. These pouches varied with the state of filling of the stomach and their inconstant character and size showed them to be functional. Finsterer and Paterson stated that pouches could be formed in a gastroenterostomy by the suturing of too large an area of the wall of the stomach and jejunum; however, the inconstant nature of the pouches would mitigate against this view in these cases. During roentgenoscopy, some of these pouches could be seen to fill and empty, and it is possible to confuse a small pouch with an ulcer niche. However, the appearance of the pouches and their behavior roentgenoscopically should help in the differentiation. The presence of pouch formation, especially when marked, was accompanied by symptomatology usually of an obstructive nature. The possibility that these pouches obstructed the stomal site is evident. The relationship of pouches to the formation of a stomal ulceration should be considered. According to Quigley, prolonged contact of food with the gastric mucosa exaggerates the gastric phase of gastric secretion and a gastric juice of high concentration develops. Experimental stagnation of gastric contents produced by folding the anterior gastric wall results in the formation of typical ulcer. There have been cases reported of gastric ulcer caused by diaphragmatic hernia in which stasis resulted.

Case 1. W. D. Patient has had pain and distress since 1918. In 1931 he was seized with an acute abdominal pain and a laparotomy was done and a gastroenterostomy was performed. The patient felt better for almost one year,



Fig. 1*A*. Case 1. 1935. No pouch seen on the filled stomach.

then developed epigastric pain and tenderness. The distress he attributed to overexertion and the symptoms had little or no relationship to his meals. In 1935 he entered the hospital and a



Fig. 1*B*. Case 1. 1935. Small pouches seen on nearly empty stomach about stoma.



Fig. 2*B*. Case I. 1943. Pouches about stomach site in various sizes during emptying of the stomach.

gastrointestinal roentgen series was done. The stoma was functioning fairly well. There was a 10 per cent retention of barium in the stomach after six hours. The duodenal bulb showed a constant deformity. The stoma in the prone position appeared to be somewhat above the most dependent portion of stomach. Small pouches are seen just above the stoma (Fig. 1, *A*, *B*). In 1937 he again entered the hospital complaining that his "stomach backs up, and stuff comes into his mouth." Roentgen examination showed similar findings to that in 1935. He also stated he had three attacks of hematemesis since the last hospitalization and he now has constant soreness over his abdomen, but no definite tenderness. The gastric analysis at that time showed a free acid varying from 0 to 28 and a total acidity varying from 9 to 38. The blood count was normal. After a regimen of medical management and bed rest, he left the hospital feeling improved. Here again entered the hospital in 1943 stating he had never been free from distress since the previous hospitalization and for the past three months vomited from one to three times a day, almost one or two hours after meals. He had lost almost 8 pounds during the last few weeks. Blood picture was normal and his gastric analyses showed a free acid varying from 30 to 40, and a total acidity varying from 30 to 44. Roentgen examination showed a deformed cap with considerable dilatation of the duodenum. Well formed pouches can be seen which apparently obstruct the stoma (Fig. 2 *A*, *B*).



Fig. 2*A*. Case I. 1937. Small pouches seen on nearly empty stomach about stoma.

Case II. J. H. In 1936 he first noted distress following meals which gradually became worse. The patient began to consume large quantities of whiskey and wine for relief with no success. He had several attacks of hematemesis and was treated for this in several hospitals. In 1938 a gastroenterostomy was done. He had no relief following the operation and again had several episodes of hematemesis, for which he was treated at various institutions by dietary and medical regimen and was hospitalized for a total period of almost seven months. He entered this hospital complaining of abdominal pain, hematemesis and diarrhea. The blood picture showed a secondary anemia and his gastric analysis showed a free acid varying from 11 to 18. The roentgen examination showed a deformed bulb with a prepyloric spasm. The gastroenterostomy opening functioned fairly well. Pouch formation was noted about the stoma (Fig. 3, *A*, *B*). He left the hospital against advice. He returned, however, several days later following an attack of acute abdominal pain

with board-like rigidity of his abdomen. Operation revealed a perforated duodenal ulcer. He recovered from this procedure and was again discharged.

Case III. W. L. This patient has had a long siege of abdominal distress and hospitalizations since 1919. In 1926, a gastroenterostomy was performed for ulcers. His distress continued, however, and he was again operated upon for removal of ulcers. In 1935, roentgen examination showed a pyloric defect apparently the result of a plastic operation. The barium passed through both the pyloric opening and the gastroenterostomy opening. There was marked spasm about the opening, causing an hour-glass appearance with pouch formation of the entire stomach on either side of the opening (Fig. 4, *A*, *B*, *C*).



Fig. 3*A*. Case II. Retouched pouch formation about stoma.



Fig. 3*B*. Case II. Tracing showing pouch of Figure 3*A*.



Fig. 4*A*. Case III. Various stages of spasm about stoma producing "hour-glass-like" deformity and pouches of stomach.



Fig. 4*B*. Case III. Various stages of spasm about stoma producing "hour-glass-like" deformity and pouches of stomach.



Fig. 4*C*. Case III. Various stages of spasm about stoma producing "hour-glass-like" deformity and pouches of stomach.

Case IV. E. F. This patient has had periodic attacks of epigastric distress since 1918. Had an appendectomy 1916. In 1921 had an operation for a perforated duodenal ulcer. The ulcer symptoms, however, continued and in 1930 a posterior gastroenterostomy was done. He felt well for almost a year following which ulcer symptoms again appeared and have been recurrent ever since. Free acid was 38, total acidity 54. Blood picture normal. Roentgen examination showed a small amount of retention after six hours with pouch seen when stomach was almost empty.



Fig. 5*A*. Case VII. Pouch formation about stoma apparently due to weight or pull of jejunal loop, consisting of pouches of posterior stomach wall.

Case V. C. M. This patient had a gastroenterostomy several years previously with continued symptoms. A large pouch was seen on one of the oblique views only about stoma.

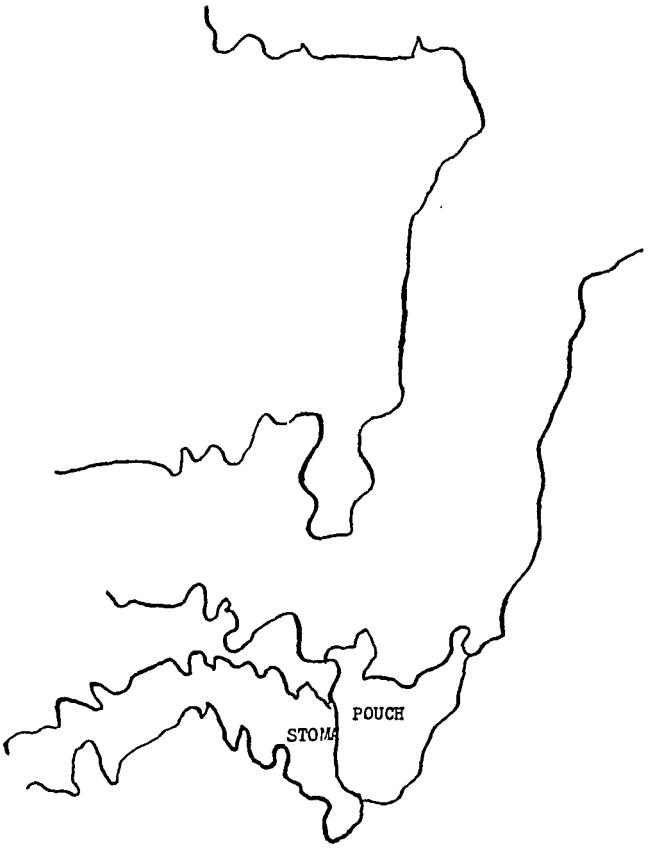


Fig. 5*B*. Case VII. Tracing of Figure 5*A*.

Case VI. O. Z. This patient had a gastroenterostomy performed several years previously for "ulcers." The patient continued to have symptoms and complained of abdominal distress which was recurrent. Roentgen examination failed to disclose evidence of ulcers. The stoma functioned, and barium passed through the pylorus. There was considerable spasm about the stoma. A small pouch was seen on the emptying film only.

CASE VII. H. W. E. In 1931 the patient had a gastroenterostomy performed for an obstructing ulcer of the duodenum. He had complete relief of gastrointestinal symptoms until recently when he complained of weakness, being "shaky," dizziness, and malaise. He had a



FIG. 5C. Case VII. Shows pouches in different view.

complicating cardiac condition. Roentgen examination disclosed a good functioning enterostomy stoma with marked pouch formation about the stoma and jejunum. Two pouches formed on the anterior and posterior side of the jejunum with a protrusion of the posterior wall of the stomach (Fig. 5, *A–D*).

COMMENT

Pouch formation, either "local" or pouches consisting of large segments of the stomach, should be searched for following gastroenterostomy in various positions including the recumbent and standing positions, especially if no cause can be found for the continued presence of symptoms. This is especially true in those cases of a poorly functioning gastroenterostomy stoma for which no cause can be found.

Diligent search and frequent examination may be necessary as the pouches are not seen at all examinations and their appearances vary.

The formation of pouches may be due to several factors. Spasm about the stomal site forming pouches similar to that of an



FIG. 5D. Case VII. Tracing of Figure 5C.

"hour-glass" stomach (see Fig. 4). Local outpocketings surrounding the stoma: These may be in effect local small peristaltic waves (see Fig. 1, 2, and 3). Local outpocketing due to the effect of the weight and pull of the jejunal loop on the stomach wall (Fig. 5).

CONCLUSIONS

1. Pouch formation occurs after gastroenterostomy, and may be an important factor in its poor functioning.

2. The relationship of pouch formation to stomal ulcers remains to be determined. An etiological factor, however, is suggested; that is, stasis and prolonged action of a gastric juice of high acidity about the stoma in the pouches may be a factor in the formation of stomal ulceration.

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THE ROENTGEN SIGNS OF GASTRITIS*

By L. WALK

IN TWO previous papers[10] I reported my investigations which resulted in a new classification of gastritis. Based on this classification I have revised the various roentgen signs which revision is now presented in the following article. The former state of the roentgen diagnosis of gastritis is seen from the publications of Ansprenger and Kirklin,[1] Schloss, Ettinger and Pratt,[8] Templeton and Schindler,[9] Schinz, Baensch and Friedl,[7] Kelley, Lawlah and Berry,[4] Renshaw,[5] and Berridge.[2]

The following essential points in my classification of gastritis differ from the former literature: The gastroscopic term "hypertrophic gastritis" is no longer used and cases previously included in this group are classified as état mamelonné or as superficial gastritis. État mamelonné is gastroscopically characterized by prominent gastric areolae resembling street pavement, and by translucent superficial epithelium; almost invariably free acid is found in those cases. État mamelonné is more frequently found in duodenal than in gastric ulcer; even if no ulcer is found, état mamelonné is frequently associated with ulcer-like clinical symptoms. Cases with reddened mucosa and with non-translucent epithelium (with or without thickened mucosal folds and prominent areolae) are classified in the group of superficial gastritis; the gastroscopic appearance as well as the clinical symptoms in this group are polymorphous. The term atrophic gastritis is gastroscopically used only if the picture of mucosal atrophy is associated with signs of superficial gastritis.

The exact diagnosis of gastritis is made only gastroscopically. Although sometimes a case can also be detected roentgenologically, this diagnosis should not be made in the roentgen department. Every report of the roentgenologist, however, should contain an exact description of signs which afterwards can be evaluated together with clinical findings. Usually I have recorded: (1) general configuration and tonus of the stomach; (2) intermediary liquid (fluid content of the fasting stomach), hypersecretion, and adherence of the barium to the mucosal surface; (3) caliber and configuration of the mucosal folds (separate notes concerning the antrum and the corpus), turgor of the mucosa; (4) regurgitation of duodenal contents into the stomach. Careful screen work is necessary. If roentgenograms (aimed exposures) are also made, it is often possible to record even the average diameter of the gastric areolae. All this can be recorded briefly, in a few words.

The first small quantity of barium for relief study is given during (not before) roentgenoscopy; manual palpation. The examination should be begun with the patient standing and not lying, as the standing position during the first minutes of the examination makes it possible to see the intermediary liquid, the secretion, and the adherence of the barium to the mucosal surface. Examination in the horizontal position, however, can be performed later.

Mucosal Atrophy. The roentgen appearance of mucosal atrophy varies considerably. There are several histological possibilities in the antrum as in the corpus gland area, giving rise to combinations; e.g. in pernicious anemia only the corpus glands are atrophic. It is therefore not to be expected to find a simple roentgenological appearance covering all those forms. Only a few cases have the typical appearance of a "dry stomach" (no intermediary liquid, absence of roentgenologically visible secretion, and good adherence of the barium to the mucosal surface) with relatively thin folds. The roentgenologist should no more than record the findings. The possibility of

* From the I. Medical Clinic of the University of Tartu.

individual variations in the thickness of the mucosal folds is to be considered. In patients with a long, vertical stomach normally the folds appear relatively thin; on the other hand, a horizontal stomach normally has relatively thick folds. In cases of irritated, tortuous folds those appear relatively thicker than they really are and may cause diagnostic errors. Functional alterations of the folds may occur, especially in the antrum. As this suggests, the roentgenologic differential diagnosis of mucosal atrophy may be difficult.

Superficial gastritis cannot, as a rule, be diagnosed roentgenologically. One may see the usual picture—normal folds, no hypersecretion, good or even remarkably good adherence of the contrast medium to the mucosal surface, normal motor function of the stomach. At the same time the gastroscope may show a reddened, markedly hyperemic mucosa with a non-translucent superficial mucous layer; usually no increased secretion is found roentgenologically in reddened, hyperemic mucosa. The diagnosis of superficial gastritis can thus be secured by means of gastroscopy only. Mucosal swelling, however, can sometimes be detected roentgenologically. Those cases have relatively thick folds; secretion, intermediary liquid and adherence of the barium show no characteristic features. If thickened folds are found roentgenologically in the corpus gland area, there are three possibilities to be considered: swelling of the mucosa, état mamelonné, and as a rarity diffuse sarcoma of the gastric wall (Walk[11]). Careful roentgenoscopy sometimes enables one to differentiate them roentgenologically, the turgor of the swollen mucosa being relatively low as compared with most cases of état mamelonné and especially with diffuse sarcoma. In swollen mucosa the folds are usually relatively low, with only narrow interspaces; on the other hand, in most cases of état mamelonné high folds with broader interspaces are found. Thickened mucosal folds have also been described in leukemia (Rigler[6]) and in lymphogranulomatosis (Jungmann[3]).

Sometimes free mucous masses are demonstrated at roentgenoscopy. In most cases, it is sputum or saliva and its demonstration seems to be of no diagnostic value. Flocculence of the barium also seems to have no diagnostic value. In cases with low fasting acidity (but not in high fasting acidity) regurgitation of duodenal juice into the stomach causes a gastroscopic picture resembling superficial gastritis; further experience, however, is needed in the evaluation of regurgitation as it is seen roentgenologically.

État Mamelonné. Although the gastric areolae can be visualized by means of spot roentgenograms, the état mamelonné cannot be diagnosed roentgenologically, as in normal cases the areolae can also be demonstrated and cannot be differentiated from those in état mamelonné. Only a few cases of état mamelonné have thickened folds roentgenologically; usually the folds appear normal and the turgor of the mucosa is a relatively high one. Hypersecretion is frequently found, sometimes together with intermediary liquid; in these cases the barium usually adheres only slightly to the mucosal surface. The same, however, can be found in normal cases also, especially in patients who have smoked on the morning before coming to the roentgen department. In a stomach with état mamelonné or with normal mucosa the barium, as a rule, cannot be easily mixed with the intermediary liquid (if the latter is present) by palpation, and the secretion usually produces a sharply demarcated layer. In contradistinction to this, in mucosal atrophy the intermediary liquid, if any, is usually easily mixed with the contrast medium. In cases of high intermediary liquid, e.g. in pyloric obstruction, this may be of diagnostic importance. In patients who have drunk water before the examination, intermediary liquid is found which can usually be easily mixed with the barium.

SUMMARY

Although gastritis cannot usually be

diagnosed roentgenologically, there are characteristic roentgenoscopic features which can be evaluated diagnostically together with clinical findings. The roentgen signs of mucosal atrophy, superficial gastritis and état mamelonné are described.

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GASTRIC RETENTION AND GASTRIC ULCER

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THE association of gastric retention with gastric ulcer of the lesser curvature has often been the subject of comment in the literature. Various opinions have been expressed, however, as to the interrelationship of these two conditions.

In 1917 Carman[3] reported 2 patients in whom gastric retention occurred with gastric ulcer. This was incorporated in a presentation of combined gastric and duodenal ulcers.

Emery and Monroe[4] in 1931 demonstrated gastric retention in 50 per cent of cases of gastric ulcer.

In 1932 Stone and Ruggles[15] stated that "In some cases of gastric ulcer that show no improvement in gastric symptoms after operation, the cause is to be sought in a hypertrophied pylorus which has resulted from a long-continued reflex pylorospasm." A case demonstrating this point is presented and illustrated. At operation a hypertrophied pylorus was found and the condition remedied by Fredet-Rammstedt operation.

Bull[2] in 1935 believed that the delayed emptying time noted in about 25 per cent of cases of gastric ulcers on the upper two-thirds of the lesser curvature was probably due to an inhibition of peristalsis since it may be present in the absence of demonstrable pyloric spasm.

In 1937 a different concept was advanced by Golden.[9] He suggested that the available evidence indicated that the prepyloric narrowing sometimes seen with gastric ulcer of the lesser curvature was on an inflammatory basis and was directly responsible for physiological and anatomical changes observed with the possible exception of the penetrating ulcer.

Feldman[6] in 1938 stated that gastric retention in cases of gastric ulceration was usually due to pylorospasm.

Also in 1938 Shanks, Kerley and Twining[14] quoted Hurst concerning the relationship between rate of gastric emptying and gastric ulcer as follows:

(1) gastric ulcer with normal pyloric function;

(2) gastric ulcer with pyloric achalasia (a reflex inhibition of relaxation resulting from a remote abdominal lesion such as an appendicular or biliary focus of irritation);

(3) gastric ulcer with pylorospasm, simulating pyloric obstruction in the early stages of the examination and later relaxing to allow the stomach to empty;

(4) gastric ulcer with pyloric obstruction in which the pylorus fails to open normally at all.

Buckstein[1] in 1940 wrote that when the gastric ulcer is at some distance from the pylorus the cause of pathologic gastric retention is not easily explained. While pylorospasm might be present, perhaps a disturbance in the gastric gradient was suggested as an important associated factor.

In 1941 Golden[10] stated that a small or moderate six hour retention is seen in about half the cases of gastric ulcer even when the crater is located relatively high. He went on to say that this retention is usually due to the interference of the ulcer with gastric motility, not to pyloric obstruction. It was also mentioned that the hypertrophy of the pyloric muscle occasionally encountered in adults, not infrequently in conjunction with gastric ulcer, was undoubtedly responsible for symptoms in some cases.

Templeton[16] comprehensively discussed the situation in 1944 from the double vantage point of gastroscopy and roentgenology. He stated that the frequent association of benign narrowing of the antrum

with ulceration along the vertical portion of the stomach has been recognized. So frequent is the association that it is imperative in his opinion to search the rest of the stomach carefully for ulcer whenever benign narrowing of the antrum is noted. He was impressed by the fact that this narrowing persists after the ulcer has healed under medical treatment which is a point against its reflex spastic origin. That the antral narrowing is not a "roentgenologic anomaly" is attested by the retention from which all the patients in his series suffered. He thought that the obstruction caused by the hypertrophy might give rise to the ulceration, but a definite relationship was not found in 20 cases studied by both gastroscopy and roentgen ray. He also stated that there was reason to believe that this antral narrowing may be caused by local inflammation in view of the work of the pathologists Serck-Hanssen,[13] Faber,[5] and Konjetzny.[12] A case is presented in which after four years of observation with intermittence of the lesser curvature ulcer, operation disclosed a narrowed antral canal with a shallow ulcer crater there and inflamed mucosa.

In 1945[7] and also in 1946[8] Feldman reiterated his previous belief that pylorospasm is nearly always observed in active cases of gastric ulcer and is usually responsible for the gastric retention.

Incidentally there were several illustrations scattered throughout the above literature which demonstrated lesser curvature ulcer, gastric dilatation and scarred duodenum without comment as to relationship.

This incomplete review of the subject reveals that at least three different mechanisms have been advanced to explain retention when seen with gastric ulcer: (1) pylorospasm; (2) interference with gastric motility as typified by the terms "achalasia," "inhibition of peristalsis," and "disturbed gastric gradient"; (3) organic obstruction due either to cicatricial stenosis, benign hypertrophy of the pylorus, or antral gastritis.

Possibly the wide diversity of opinion as to the findings at the pylorus is partially due to lack of definitive methods of study especially in the earlier reports. By this is meant, specifically, the use of aimed and regulated compression to bring out mucosal detail with a moving or fixed grid. Then various organic and functional conditions can usually be differentiated. A simple method of accomplishing this end has been reported by one of the authors of this paper.[11]

In this paper evidence is presented to show that in some patients with the complex under discussion, obstruction is produced by scarring from a duodenal or pyloric ulcer and that the lesser curvature ulcer develops after the gastric retention. The 2 cases which first directed our attention to this sequence of events are presented below. In both, repeated examinations had established the steps in the development of the two conditions. At the time of the original examinations, both patients had peptic ulceration in the duodenum near the pylorus and in neither was any gastric lesion present. Subsequent study showed the development of stenosis and gastric retention. With this, widening of the rugal folds throughout the entire stomach appeared, producing the picture of so-called hypertrophic gastritis. Both of these patients then developed ulceration of the lesser curvature.

REPORT OF CASES

Case 1. R.N., aged thirty-nine, American housewife. Admitted to the hospital on March 12, 1938, with history of sudden onset of severe epigastric pain twelve hours before admission. Patient stated that she had been having epigastric distress almost continuously for a period of eight years. Pain would come on one to two hours after meals, relieved by food and soda bicarbonate. Physical examination showed board-like rigidity and extreme tenderness over entire abdomen. A diagnosis of a perforated peptic ulcer was made and immediate operation performed. The peritoneal cavity contained free exudate. A perforation was found in the duodenum. Adhesions were present between



Fig. 1. Case 1. 1938. Showing deformity due to duodenal ulcer.

the duodenum and the under surface of the liver. The perforation was sutured and the abdomen closed without drainage. Recovery was uneventful. Roentgenographic examination on April 4, 1938 (Fig. 1), showed deformity of duodenum and slight six hour retention. There was no evidence of a gastric lesion.

Patient was followed in the out-patient department. Her condition remained fair. She had some epigastric pain and complained of splashing and discomfort in epigastrium. Physical examination showed a dilated stomach with some visible peristalsis. Refused admission for operation. Had three courses of larostidin injections.

On November 16, 1940 patient vomited large quantities of blood and had black stools.



Fig. 2. Case 1. 1941. Three years later. Shows duodenal deformity still present. Also large ulcer of stomach.



Fig. 3. Case 1. 1941. Six hour roentgenogram showing large gastric residue.

She was in bed at home for seven weeks; had a second gastric hemorrhage on January 23, 1941. Admitted to the hospital on January 27, 1941.

Roentgenographic examination on January 29, 1941, showed evidence of pyloric stenosis and of a new large ulceration on the lesser curvature (Fig. 2). A large amount of barium was retained in the stomach after six hour examination (Fig. 3). Roentgen findings confirmed at operation. Gastric resection and gastroenterostomy performed. Patient was symptom free, for the first time in eight years.

Case II. E.S., male, aged forty-two, Swedish

janitor. First examination on May 24, 1937. He presented a history of having been roentgenographed in Sweden in 1933 with resulting diagnosis of peptic ulcer. He had been well on a restricted diet until four months before examination, when recurrence of symptoms had been induced by dietary indiscretion. Roentgenograms showed deformity of pylorus and duodenal cap indicating ulceration at or near the pylorus (Fig. 4).

Patient was placed on ulcer regimen and continued to have some epigastric pain. He was



FIG. 4. Case II. 1937. Deformity of duodenum due to ulcer.

followed in the hospital and in the out-patient department but surgical intervention was not urged due to the fact that the patient had been found to have a luetic aortitis.

Symptoms continued with some increase in severity toward end of 1940. Readmitted to the hospital on January 10, 1941.

Roentgenographic examination on February 3, 1941, showed large ulcer crater in the mid lesser curvature (Fig. 5) and at six hours a large gastric residue was present, indicating pyloric obstruction (Fig. 6). These findings were subsequently confirmed at operation.

This presentation does not imply that the majority of cases of gastric ulcer are



FIG. 5. Case II. 1941. Four years later. Shows duodenal deformity and large ulcer of the lesser curvature.

secondary to gastric retention. In our experience most lesser curvature gastric ulcers

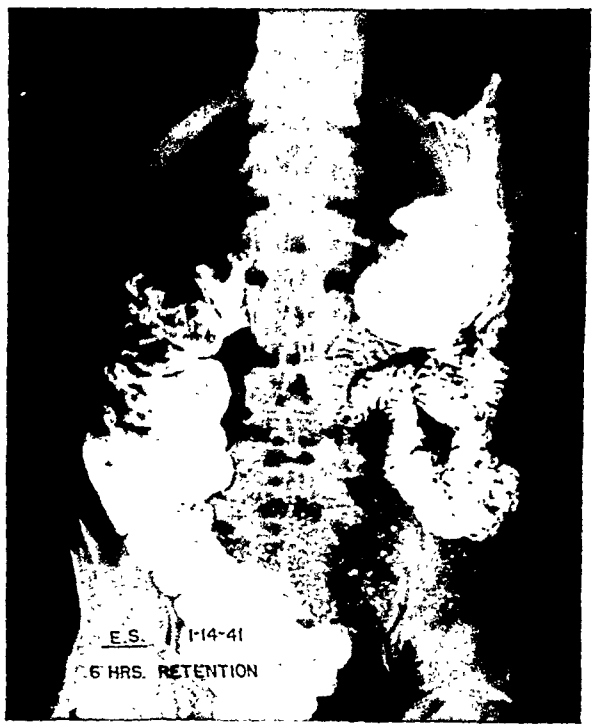


FIG. 6. Case II. 1941. Six hour roentgenogram shows gastric retention.

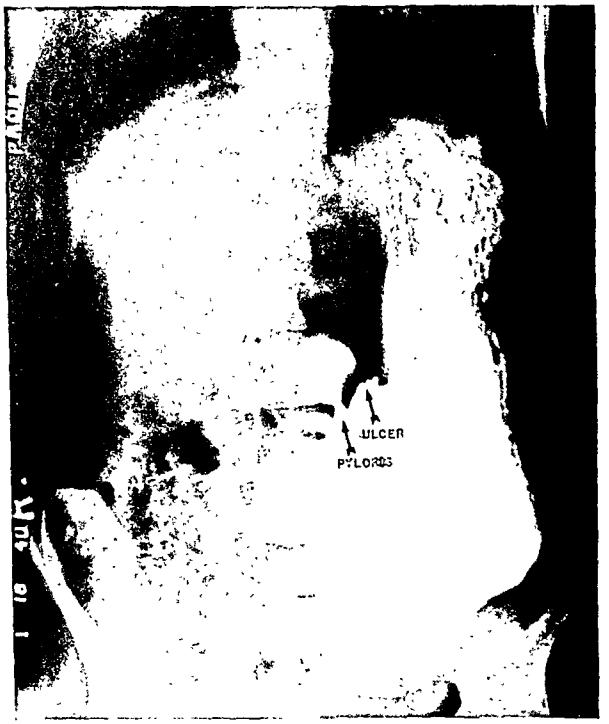


FIG. 7. Case III. Roentgenogram shows contraction of lesser curvature with pylorus drawn up to the base of the ulceration on the lesser curvature.



FIG. 8. Case II. Six hour roentgenogram shows retention in the stomach and demonstrates the involvement of the pylorus by the induration at the lower margin of the ulcer.

show no evidence of pyloric obstruction and no retention on the six hour roentgenogram.

To round out the picture a different condition is presented in which gastric ulcer and gastric retention are associated, as illustrated by the following case report. Here a large ulcer on the lesser curvature was present in which the inflammatory and cicatricial changes had extended some distance to the pylorus which became stenotic due to direct involvement. The roentgenographic appearance in this condition has variously been termed "purse-string stomach," "Beutelmagen," "snail-like retraction," and "schneckenformige Einrollung," "rolling in of antrum," and other equivalents in different languages.

CASE III. C.R., aged forty-six, American housewife. On admission the patient complained of pain in epigastrium off and on for a period of six months. She had lost 5 pounds in weight. No abdominal operations. Roentgenographic examination in this case showed a large ulcer crater on the lower lesser curvature (Fig. 7). It will be noted that the induration and scarring about the ulceration extends to and involves the pylorus. The entire lower lesser curvature has been shortened due to cicatrization producing a pouch stomach. Figure 8 shows the large gastric residue at six hours. The ulcer crater and its surrounding induration are well demonstrated.

COMMENT

Our own material was originally assembled in 1941. During the war years the project was interrupted. In 1946, however, sufficient examples of the end stage of the condition were observed to indicate that it occurs fairly frequently. The practical point to be gleaned from this report is that response to treatment of the gastric ulcer in this complex is materially dependent upon the alleviation of the gastric retention by medical or surgical measures.

CONCLUSION

Gastric retention due to organic obstruction at or near the pylorus often precedes

and may have a causal relationship to the subsequent development of gastric ulcer of the lesser curvature.

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GALLSTONE ILEUS ASSOCIATED WITH DIVERTICULITIS OF THE COLON

A CASE REPORT

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THE following case of intestinal obstruction due to a gallstone is presented because of several unusual and interesting features. Among these were the occurrence of the impaction in a region of the sigmoid concomitantly involved by diverticulitis, and the recovery of the patient under conservative treatment. We wish to re-emphasize the importance of including gallstone ileus in the differential diagnosis of intestinal obstruction, especially in an elderly female with an antecedent history of gallbladder disease.

CASE REPORT

M.D., a housewife, aged seventy-two, was admitted to this hospital for the first time on March 1, 1946 with a seven day history of progressively increasing nausea, vomiting, and colicky abdominal pain. The pain had its onset in the epigastrium and then radiated to the left para-umbilical region and the left lower quadrant. During the two days prior to hospitalization there were abdominal distention and obstipation.

The medical history revealed that in the past ten years there had been two acute episodes of what had been regarded by her private physician as "gallbladder attacks." In roentgenograms made five months prior to her present illness, the gallbladder failed to visualize after administration of oral dye. No opaque calculi were apparent in the right upper quadrant of the abdomen at that time. Four years previously she had had a hysterectomy for uterine

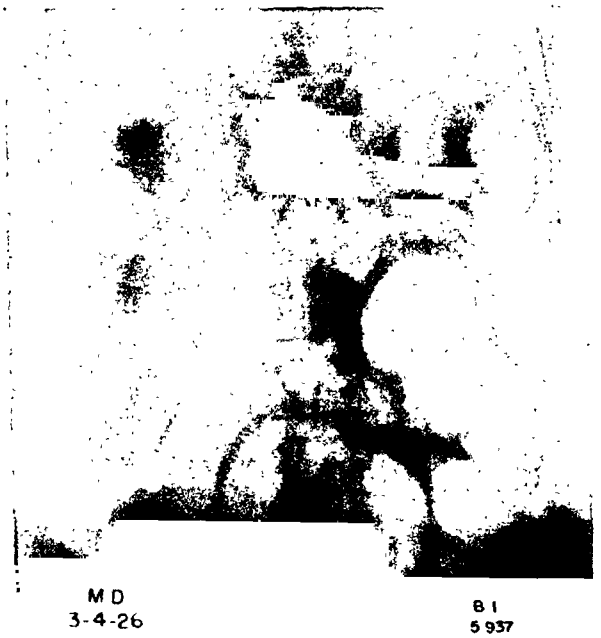


FIG. 1. Roentgenogram of abdomen, in upright position showing marked dilatation of loops of large and small intestine and the presence of fluid levels. (Date should be 3-2-46, not 3-4-26.)

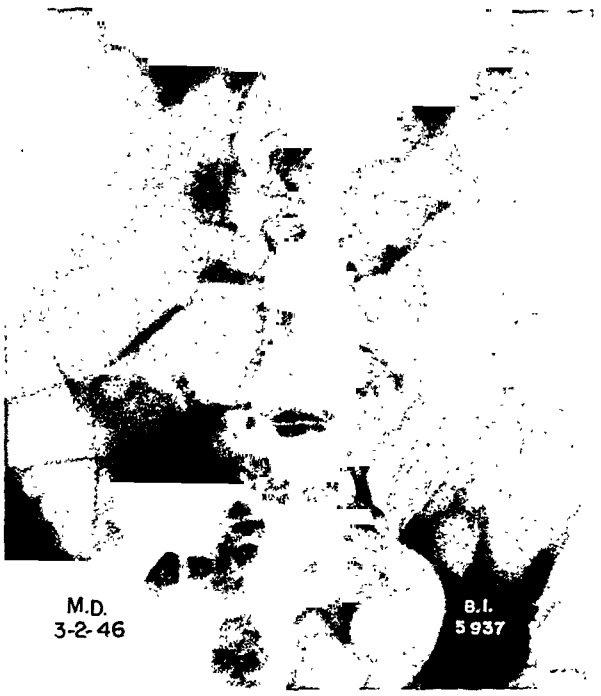


FIG. 2. Roentgenogram of the abdomen, in the horizontal position, showing marked dilatation of loops of large and small intestine.

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FIG. 3. Barium enema done on the fourth hospital day. Note presence of a diverticulum in proximal sigmoid, associated with narrowing of the lumen at this point (lower arrow). Area of decreased density in transverse colon (upper arrow) represents gallstone dislodged by the influx of the enema.

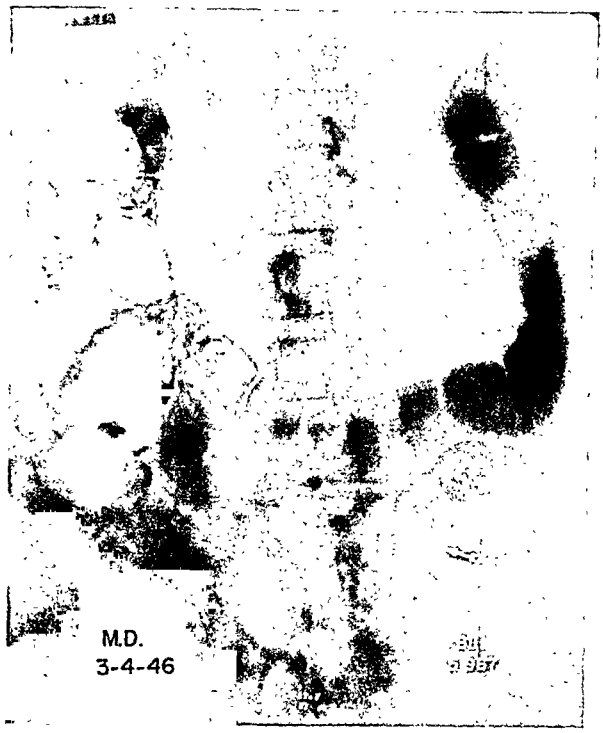


FIG. 4. Post-evacuation roentgenogram showing area of decreased density at junction of sigmoid and descending colon, with narrowing of sigmoid just distal to it (arrow). Area of decreased density has the size and shape of the gallstone passed spontaneously (Fig. 5).

myomas. She had been troubled with moderate constipation for many years.

Physical examination upon admission revealed a moderately obese, acutely ill elderly female, who appeared somewhat dehydrated. The temperature was 99.8°F., pulse 96, respirations 22, and the blood pressure 146/70. The heart and lungs were essentially normal. There was a moderate degree of abdominal distention with some tenderness in the epigastrium and right upper quadrant. No masses could be palpated either abdominally or rectally.

The laboratory findings were: urine, negative; leukocyte count, 6,900 with a normal differential count; erythrocyte count, 3,900,000; hemoglobin, 12 grams.

Roentgenograms of the abdomen, made on the second day of hospitalization, in the upright (Fig. 1) and horizontal (Fig. 2) positions revealed marked dilatation of loops of small and large intestine with the presence of fluid levels. The impression was that a mechanical intestinal obstruction existed with the site of obstruction in the distal colon.

Under supportive therapy, with repeated enemas, the patient's condition slowly improved and she began to evacuate spontaneously small stools which were occasionally blood streaked.

On the fourth hospital day the colon was examined by means of an opaque enema (Fig. 3 and 4). The roentgenograms demonstrated the presence of a diverticulum in the proximal portion of the sigmoid, which was associated with a considerable amount of narrowing of the colon in this region. Just proximal to this constriction there was noted a negative shadow within the barium-filled colon which was regarded as feces. The narrowing was thought to be due to either a neoplastic or inflammatory process, and reexamination at a later date was recommended.

The patient continued to do well, and on the fourteenth hospital day the barium enema was repeated, with findings similar to those of the preceding examination, except that at this time the lumen of the constricted segment of the sigmoid was somewhat wider. It was felt, therefore, that the second examination favored the diagnosis of diverticulitis rather than neoplasm. It was decided that the patient be

treated with mineral oil and antispasmodics for about two weeks before another study of the colon was made.

Eighteen days after admission the patient was discharged with the diagnoses of (1) subacute intestinal obstruction, improved, (2) diverticulitis of the sigmoid, and (3) possible neoplasm of the sigmoid. Her course at home proved to be uneventful until the seventh day, when she passed a hard dark object during a bowel movement. Upon examination, which included laboratory analysis, this object proved



FIG. 5. Roentgenogram of gallstone passed by patient Compare with Figure 4.

to be a gallstone (Fig. 5), which measured 2.5 by 3.5 cm. Unfortunately the actual site of the fistula between the gallbladder and intestinal tract was not demonstrated on our roentgenograms, and the patient refused to return for further roentgen studies.

DISCUSSION

Because the incidence of gallstone ileus is low, the possibility of its presence is more often than not disregarded in any one individual instance of intestinal obstruction. Various authors gave the incidence of intestinal obstruction due to gallstones as ranging from 0.4 per cent to 5 per cent of all cases of bowel obstruction.[6] The importance of the early diagnosis of this condition is to be emphasized, for without timely surgical intervention the average mortality rate is about 50 per cent.

It is uncommon for the site of impaction of a gallstone to be in the large bowel. In a review of 150 cases of gallstone ileus, Foss and Summers[3] found that in 125 cases (83 per cent) the stone lodged in the ileum. In 88 of these cases (59 per cent of the total number), the site of obstruction was the terminal ileum, and in only 5 cases (3.3 per cent) was the obstruction encountered in the colon or rectum. It is interesting to note that in his discussion of the above paper, Dr. E. Vernon Mastin reports a case of his own somewhat similar to the one herein presented. In his case a large gallstone became impacted in a diverticulum of the rectosigmoid region where there was also an associated stricture of the bowel.

It is felt that in the present case the gallstone would have passed spontaneously had it not encountered the spastic narrowing of the sigmoid at the site of the diverticulum. Later, when the spasm was relieved, the gallstone was passed.

While it is generally admitted that the recognition of gallstone ileus preoperatively is very infrequent, even with the aid of appropriate roentgenograms, in retrospect we feel the diagnosis might have been made in our case. In Figure 4 (post-evacuation), a negative shadow, which corresponds closely in size and shape to the gallstone later recovered by the patient, is seen just proximal to the stricture in the sigmoid. Evidently, during the administration of the barium enema, the stone was temporarily dislodged, for on one roentgenogram (Fig. 3) it can be seen in the transverse colon. The demonstration that the stone was not permanently lodged in the sigmoid, and the fact that the obstruction was partially relieved by the enemas which the patient received undoubtedly explain why, in the course of treatment, the intestinal obstruction was neither complete nor persistent.

SUMMARY

1. A case of intestinal obstruction due to a large gallstone in the sigmoid, associated with diverticulitis of the sigmoid, is presented.

2. The interesting features of the case

are discussed and some references made to the literature.

3. Emphasis is placed on the importance of considering gallstone impaction in the differential diagnosis of intestinal obstruction, especially in elderly females who give a history of gallbladder disease.

Appreciation is extended to Dr. Louis Greenwald of New York City for his kind permission to report this case.

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SUGGESTED OUTLINE FOR THE TRAINING OF RADIOLOGISTS AT QUALIFIED UNITED STATES NAVAL HOSPITALS*†

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PREFACE

At the request of the Head of the Training Branch, Bureau of Medicine and Surgery, Navy Department, I was asked to prepare an outline for the training of naval medical officers in radiology that would lead to their certification by the American Board of Radiology. In attempting to do this, it soon became apparent that very few articles had been written on this subject, and actually, few references were available.

In formulating this outline the counsel of radiologists who had served in the Navy was sought and used to make this a working basis for general use in the naval hospitals. During this survey considerable interest was expressed by various physicians who were preparing similar programs of postgraduate training for the Army Medical Corps, for the Veterans Administration, and for the United States Public Health Service. Because of the widespread interest, it was felt that the publication of this outline might be helpful to those who were charged with similar responsibilities and at a time when considerable discussion is still going on with respect to postgraduate training in radiology. It should be emphasized that this outline serves only as a basis for a working program. An effort was made to simulate as nearly as possible the type of training that is being carried on in qualified civilian hospitals over the country.

INTRODUCTION

ANY program for the training of naval medical officers in radiology must necessarily be directed toward fulfilling the requirements established by the American Board of Radiology. The program as outlined below is intended to fulfill these requirements and, in addition, to do so in a manner that is practical within the organization and setup of the Medical Department of the United States Navy.

It is highly desirable that such a training program should be carried out uniformly in all the naval hospitals as regards subject matter and the chronological order and sequence in which it is given. In doing so, it makes it feasible for a medical officer to embark on a three-year period of training in radiology and still be available for transfer, although such transfers should be avoided if at all possible during said training period. At the same time, it is recognized that administrative problems and the physical setup of the individual departments in the various hospitals vary and that the proposed schedule of training must be adapted to meet the local conditions. Yet the aim should always be toward the development of a uniform program in the naval hospital designated for training in radiology.

The suggested hours and time allotted for the various divisions of radiology are recommendations. In adding up the total hours arranged per day, the total may exceed eight hours, but several of the assignments are overlapping and can be carried on simultaneously.

It is imperative at all times that a radiologist certified by the American Board of Radiology be in charge of the departments at the naval hospitals designated for training in radiology.

Definitions. The medical specialty of radiology includes the divisions listed below, and the American Board of Radiology can certify a medical officer in any of these

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† The opinions or assertions contained herein are the private ones of the writer and are not to be construed as official or reflecting the views of the Navy Department or the Naval Service at large.
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branches. This training program is directed toward qualifying medical officers in Radiology or Roentgenology, as it is felt that medical officers certified in these divisions will be more competent to handle the work that is required of radiologists in the larger naval hospitals. The following definitions were taken from the booklet. "The American Board of Radiology," 1946:

1. *Radiology* is that branch of medicine which deals with the diagnostic and therapeutic application of radiant energy, including roentgen rays and radium.
2. *Roentgenology* is that branch of Radiology which deals with diagnostic and therapeutic application of roentgen rays.
3. *Diagnostic Roentgenology* is that branch of Radiology which deals with the diagnostic application of roentgen rays.
4. *Therapeutic Radiology* is that branch of Radiology which deals with the therapeutic application of roentgen rays and radium.

General Requirements. Each applicant, for admission to the examination, is required to present evidence that he has met certain general standards which are already required of naval medical officers.

An applicant must also be a graduate of a medical school recognized by the Council on Medical Education and Hospitals of the American Medical Association.

It is also necessary that applicants must have completed an internship of not less than one year in a hospital approved by the same Council.

The American Board of Radiology further requires that after completion of the internship all applicants must receive a "period of special training in radiology of not less than three years in clinics, hospitals, and dispensaries recognized and approved by the American Board of Radiology and the Council on Medical Education and Hospitals of the American Medical Association as competent to provide a satisfactory training in radiology." This period of specialized training shall include:

(a) Graduate training in pathology, radiation physics, and radiobiology.

A period of six months' full-time training in pathologic anatomy is recommended, but where this is not possible to arrange the student, during his three-year training period may, by attending pathologic conferences, postmortem examinations, and studying removed tissues, receive adequate training in pathology. It is recommended that radiation physics be taught by a combination of didactic lectures, practical examples, and direct clinical demonstrations.

(b) An active residency of not less than 24 months in a recognized and approved radiological department by the above organizations.

(c) The examination includes the basic sciences of Radiology as well as the clinical aspects thereof.

OUTLINE FOR THREE-YEAR TRAINING PERIOD IN RADIOLOGY

The working period is based on eleven months' active work each year, with the twelfth month being allotted for a vacation period. Each day's work is based on a seven and a half hour working period, exclusive of time required for lunch, and is based on a five and a half day week.

1. *Continuous Courses During the Three-Year Period.*

 (a) In naval hospitals, as in most civilian hospitals, it is impractical to spend a six months' full-time training period in pathology. Consequently, to fill the requirements of the Board, it is essential that the student:

 1. Attend the clinical-pathological conferences conducted by the department of pathology.
 2. Attend the postmortem examinations conducted in the hospital.
 3. Make rounds with the staffs of the orthopedic and chest services at least once a week in order to be familiar with the clinical demands of these services and to aid them in their diagnostic and treatment problems.
 4. Develop a personal contact with members of the department of pathology who will instruct him in the gross and microscopic examination of tissues removed at operations, biopsies,

and autopsies. Such training will not only aid the student in the interpretation of the pathologic processes as recorded on the roentgenogram, but will make him more familiar with tumor tissue.

(b) A monthly pathologic-radiologic conference should be held jointly by the two departments, at which the gross and microscopic specimens obtained from operations, biopsies, and autopsies are available. Roentgenograms and roentgenographic examinations made on these cases should be demonstrated and the roentgen diagnosis discussed, after which the pathologic material is presented and compared with the roentgen findings.

(c) It should be mandatory for the medical officers undergoing training in Radiology to attend the meetings and clinics conducted by the Tumor Board at their respective hospitals.

(d) Throughout the training period all trainees should attend the meetings of the local radiological society as well as those conducted by the radiological departments at the neighboring medical schools.

2. *Program for First Year: (Intern in Radiology).*

(a) Instruction in dark-room and film processing techniques:

($\frac{1}{2}$ day for 4 weeks)

A thorough understanding and familiarity with film processing techniques is essential for naval radiologists who may be called upon to set up dark rooms in far-away places under difficult circumstances and possibly without trained technical assistance. Trainees should become familiar with the preparation of the developing and fixing solutions, with the proper storage of films; and with the mechanical means of maintaining the chemical solutions at the proper temperature.

(b) Instruction in roentgenographic technique and procedures:

($\frac{1}{2}$ day for 10 months)

Only from experience gained in positioning the patients and in the actual taking of the roentgenograms can the trainee achieve confidence and a feeling of security in doing roentgenography. It is not the purpose to have him serve as a technician, but rather to have him share in the responsibility for the production of the general roentgenographic work during the first year. Only by actually operating the machines will he become familiar with them and learn their capacities and limitations. He should also assist in the more advanced diagnostic roentgenographic procedures during this period. This includes experience in the operation of mobile diagnostic equipment. The importance of good technical work and the radiologist's ability to perform it cannot be overstressed.

(c) Instruction on film interpretation:

(Approximately 2 hours daily for 11 months)

Trainees should attend the film reading sessions and after a few weeks should be assigned a certain group of roentgenograms for interpretation and the preparation of the report. This, of course is done under supervision and is checked by the radiologist.

(d) Instruction in office procedures, in the film filing system, and in the maintenance of the pathologic cross-file of roentgen reports:

During this first year, the trainee should be instructed in the film filing system and in the maintenance of the pathologic cross-file of roentgen reports. The latter is important because every naval hospital must maintain such a cross-file. It is one of the requirements for certification for residency training in radiology by the American Medical Association.

(e) Lecture course and demonstrations in radiation physics:

(Minimum of 16 one-hour lectures and demonstrations)

This course can be conducted in one of three ways:

(A) By having the local Consultant in Radiology arrange for the trainees to attend the course on Radiation Physics that is given in the department of radiology at a nearby medical school.

(B) By having the Chief of the Department of Radiology at the naval hospital hold a seminar each week for the trainees and systematically

going through each chapter in one of the standard textbooks on this subject.

(C) A third and perhaps the best method of conducting a course in radiation physics is one suggested by Dr. John D. Camp, Chairman of the Commission on Education of the American College of Radiology. He has suggested that the Bureau of Medicine and Surgery could assemble the necessary naval and civilian instructors for this course at some central hospital (Brooklyn or Bethesda) and order their residents in radiology for temporary duty for such a course of whatever duration would seem indicated. Since the training program is of a three-year period, only the third-year men would be in attendance at the same time, and in this way, the instruction course could be carried on without handicapping the routine clinical work in the department. Such a course would provide a more uniform basis of instruction given by the best specialists in this field. This course could be considered as a final and graduate review of radiation physics and would necessarily be amplified by local instruction as indicated above in "A" and "B."

3. *Program for Second Year: (Assistant Resident in Radiology).*

(a) Instruction in diagnostic roentgenology of the gastrointestinal tract.

(Each morning for 11 months)

With the background of basic training gained during the first year, the trainee should now be allowed to concentrate a large part of his energies in perfecting his skill and knowledge of gastrointestinal roentgenology. This field is one of the most difficult to master but one of the most important. Gastrointestinal examinations form a large part of the work done in the radiological departments of naval hospitals and must be done with a high degree of accuracy, as results can greatly influence the career of military personnel.

(b) Instruction in roentgenological examination of the urinary tract.

(To be worked in with morning gastrointestinal examinations. Intravenous urological examinations may be scheduled for convenient times)

Throughout the year the trainee should conduct the intravenous urographic examinations under the supervision of the radiologist. Instruction should include indications, contraindications, precautions to be exercised in this examination, and the technique of injection. The trainee should make the preliminary interpretation of the films and prepare the final report after consultation with the radiologist. When practical, the trainee should be present during most of the retrograde urographic examinations to become familiar with this procedure as well as cystograms and urethrograms.

(c) Instruction in special roentgenographic procedures.

(As scheduled in the Department of Radiology)

It is realized that instruction and mastery of the following roentgenographic procedures cannot be confined to just the second year. This work, obviously, must be started in the first year and developed throughout the three-year period; but special effort should be made to see that the trainee becomes familiar with these various techniques and thoroughly understands them. It is probable that instruction in several of the techniques can be gained only in civilian hospitals, and it is one of the duties of the Consultants in Radiology to see that the trainees in the naval hospitals obtain instructions in these methods:

1. Spinal myelography
2. Pneumoencephalography and pneumoventriculography
3. Bronchography
4. Body section roentgenography
5. Roentgen kymography of the heart
6. Visualization of the heart and great vessels by the use of contrast media
7. Catheterization of the heart and venous system (in certain institutions, only)
8. Exploration of sinus tracts and fistulae with opaque materials

(d) Film interpretation.

(Approximately 2 hours daily for 11 months)

During the second year the trainee should be given more responsibility both in quantity and in the range of roentgenograms for interpretation. This should still be guided and supervised.

(e) Introduction to superficial and deep roentgen therapy and radium therapy.

(Approximately one hour daily for 11 months)

Beginning the second year, the trainee should be introduced to superficial and deep roentgen therapy by attendance for at least one hour during the routine period of superficial and deep roentgen therapy as well as an opportunity of observing what radium therapy may be carried on at that particular hospital. During this period he should examine the patients undergoing treatment with the radiologist, observe their response to treatment, and see them at the follow-up examination. He should also become familiar with the operation of the therapy machines and the standard techniques that are used. He can profit by reading the standard reference books on radiation therapy.

4. *Program for Third Year: (Resident in Radiology).*

(Approximately 2 hours daily for 11 months)

During the third year the trainee should be considered as Resident in Radiology and, consequently, should be given considerable responsibility in diagnostic roentgenology and in the general operation of the department. During this year the main effort in teaching should be concentrated on roentgen and radium therapy.

(a) Film interpretation:

(Approximately 2 hours daily for 11 months)

During the third year the trainee should be given considerable responsibility in the interpretation of roentgenograms and in the preparation of the reports. He should also be allowed considerable freedom in directing the activities and assignments of the intern and assistant resident in radiology.

(b) Lecture course and demonstrations in radiation physics:

(Minimum of 16 one-hour lectures and demonstrations)

It is felt that the Resident should repeat this course and, at the same time, should take an active part in the preparation of several of the lectures and demonstrations.

(c) Advanced instruction in superficial and deep roentgen and radium therapy:

($\frac{1}{2}$ day for 11 months)

It is during the third year that the trainee should concentrate on learning radiation therapy because he has grasped the fundamentals of radiation physics and has had one year of limited experience in therapy. He now should see the new patients in consultation with the radiologist, outline the course of treatment, and actually carry out the treatments on a group of patients.

In most instances, the variety and quantity of radiation therapy are somewhat limited in all but a few of the naval hospitals, and for this reason the third year is the most desirable period for the trainee to obtain a year's training in a department of radiology in a civilian hospital. In this way he will have not only greater opportunities to see more patients undergoing radiation treatments, but also an opportunity to observe and participate in the many specialized roentgenographic examinations and procedures that are less frequently done in naval hospitals. These same facts apply to radium therapy. He should see or perform at least ten radium applications for cancer of the cervix uteri.

The trainee must be instructed in the use of radioactive isotopes as used in radiation therapy and have a working knowledge of their application as "tracers." It is further desirable that the trainees as well as the radiologists in the Navy make application for one or more of the various courses that are offered by the Navy Department in the use and hazards of radioactive materials.

(d) Preparation of a manuscript for publication:

The first year the medical officer starts his training in radiology, he should be informed that he is expected to prepare a paper for publication on some subject in radiology, preferably the results of some investigative work. The subject matter and work should be guided and supervised by the radiologist or undertaken with him on a joint basis.

DUTIES OF THE RESERVE CONSULTANTS IN RADIOLOGY ASSIGNED TO NAVAL HOSPITALS

These officers are to act as consultants in developing, strengthening, and promoting the department of radiology in that hospital. They must work closely with the radiologist assigned to the hospital and with the commanding officer.

The success of the resident training program in radiology in naval hospitals is contingent upon finding qualified radiologists who are competent and trained in the teaching of radiology. This is a difficult problem because naval medical officers are not trained in the same manner as radiologists in teaching institutions. Therefore, the real duties of the civilian Consultants will be to supplement this deficiency and bring to the naval hospital the advantages of their teaching experience.

There should be no limit to the number of civilian Consultants in Radiology to any qualified naval hospital. The number should depend on the needs and requirements of that particular naval hospital. Only by the assignment of sufficient Consultants can the teaching program be comparative to that achieved by university departments of radiology.

Specifically, the duties of the Consultants may include such items as the following:

1. Assist in the development and continued maintenance of an acceptable cross-file of the diagnostic roentgen reports.
2. Assist in the training program of the resident staff along the lines outlined in the preceding report, and help in maintaining a continuity of the program during the transfers of the chiefs of the department of radiology.
3. Make arrangements to supplement the teaching of the resident staff to fulfill the requirements of the American Board of Radiology in the courses, clinics, and seminars that are conducted in the radiological departments of the local civilian hospitals and medical schools. The Consultant can be especially helpful in arranging for the resident staff to attend courses in radiation physics, superficial and deep roentgen therapy, radium therapy, and in the clinical-pathological conferences.
4. The Consultant can also be extremely helpful in seeing that the radiological work is conducted and maintained at a high standard of professional efficiency and accuracy. He can also be helpful in an advisory capacity in the selection of equipment and in the maintenance of that equipment. If possible, he should be present at the radiological-pathological conferences and can often supplement them by bringing interesting roentgenograms and pathological specimens from his own collection.

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TRIBUTE TO WILHELM CONRAD RÖNTGEN*

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WE, the American specialists in roentgenology and curietherapy, have met today for the purpose of paying tribute to the discoverer of the roentgen ray and to recollect the important progress that has been made by this science and the benefits which humanity has derived from it during the fifty years that have elapsed since that historical eighth of November, 1895.

The President of this Congress has decided that a member of the Colombian delegation be selected for paying this tribute tonight to the name and work of Röntgen, and also to record the influence which his discovery has had on 20th century medicine—a grave charge which I have accepted with devotion and pride not with the intention of relating to you the life of Wilhelm Conrad Röntgen or the details of his discovery, or his well known scientific work in the field of physics, because you already know all these better than I do; you have studied them profoundly and your disciples have learned them all from your lips. My only desire is to describe graphically some of the outstanding characteristics of his clearly defined personality as a man and as a scientist, so that they may serve us as a guide and as an example in our every day tasks.

And I also hope that we can find time to meditate for a moment upon the contribution which roentgenology has made to the medicine of our century and upon that which it promises to do in the future in diagnosis and treatment.

On recalling that memorable meeting, held on January 23, 1896, of the Medical-Physical Society of Würzburg, whose fiftieth anniversary we have just celebrated, this question comes to our lips:

Why are the rays which were discovered by Röntgen called today x-rays, when the unanimous and enthusiastic approval given at that time to the proposal of Professor Kölliker was that they be named roentgen rays?

I frequently evoke the details of the meeting held in January, 1896, because, for Röntgen and for the town of Würzburg as well, those were undoubtedly the most exciting hours that followed the unforgettable evening of his discovery. I am thinking of the smallness of the great lecture hall for accommodating the scientists, countrymen and friends of Röntgen who gathered hurriedly to see for themselves the marvellous discovery which, for two months, had moved Europe and America on account of its amazing novelty.

We who have witnessed the birth of the atomic bomb can imagine how Röntgen's rays must have confused and aroused the imagination of the men of that time. Not only was the discovery of the rays not inferior to that of the bomb, but it was created by only one mind, and in search of some ray of hope for relieving humanity of the terrible diseases that afflicted it. What a difference from this other invention, the object of anxiety and anguish due to the destruction it may cause in the future to humanity—our humanity that is so fond of sowing hatred and destruction among those who should be brothers, companions and collaborators!

Silence reigned in the room during that August assembly, when, after Röntgen's simple but glorious explanation, Professor Kölliker went forward to have his hand roentgenographed for the first time, and then that numerous and select audience burst out with a murmur of restrained admiration on seeing the bones of the hand

* Address delivered on Tuesday evening, November 20, 1946, at a Solemn Session in commemoration of the discovery of the roentgen rays, at the Second Inter-American Congress of Radiology held in Havana, Cuba, November 17–22, 1946.

photographed on the plate. And the words with which Professor Kölliker ended his dissertation were nothing but the reflection of a unanimous sentiment of praise and gratitude to him who so modestly gave to the world the result of his discovery—roentgen rays. This is what the whole gathering requested as an immortal name for these radiations.

What happened then, I ask, to prevent the scientific world, fifty years later from continuing to call these radiations roentgen rays? The answer is—the modesty of the discoverer. His inborn modesty led him, in fact, on every occasion on which he presented a communication or gave a conference, to call them x-rays. And as his work was and still is the basis and unyielding foundation of them, he himself succeeded, contrary to the desires of the whole world, in causing his name to be forgotten in connection with the rays which, in spite of their well known characteristics, are at present usually called x-rays.

But furthermore I find that this x, symbol of the unknown, attracted greatly the attention of the whole world, as the marvellous and surprising properties of the rays called for a name capable of conveying to the mind the idea of the unreal and the supernatural. It is believed today that, due to their unknown characteristics, it was natural that Röntgen should call them x-rays. And it is precisely necessary that an explanation be made in this respect. It would be sufficient to read his three original communications in order to be convinced that the discoverer was in no doubt at all about the nature of the rays. He supposed and demonstrated that they had to do with certain radiations having properties similar to those of light; and on applying the "x" he did nothing more than fix, by means of a letter, the name of an unknown radiation when stating the equation, but of an equivalent well known to him when solving it. Let us listen to his own words.

> There must be some relation between the new radiations or Rays and the radiations or rays of the sun. At least this is indicated by the formation of shadows, the fluorescent properties, and the chemical effects which are common to both radiations.

To Röntgen, those radiations were, from that time, what they are now: a form of light.

Röntgen's name still prevails among many scientists for designating the science of x-rays and, for this reason, many societies are called roentgenological societies. But as that science became enriched later with another and also unforgettable discovery—radium—its combination has been called Radiology. In truth we should speak of roentgenology and curietherapy for indicating these two branches of medicine created by the discoveries of Röntgen and Pierre and Marie Curie. Unfortunately as there is no generic name which includes both without disregard to their discoverers, that of radiology has been adopted for the sake of conciseness. And what better proof is there than that of attending the Second Inter-American Congress of Radiology? Does it not seem more fitting to you that from now on we call these meetings The Inter-American Meetings of Roentgenology and Curietherapy? In this manner we should honor their discoverers and prevent the very general denomination of Radiology from being interpreted by the ignorant as being the science of all luminous radiations, from the light of x-rays and of radium to that of the hertzian waves.

It is impossible to dispense with that so suggestive and renowned "x," and if we are unable to forget that marvellous metal "radium" I ask you that, at least, the societies, assemblies and professorships engaged therein, bear the names of their discoverers. We should no longer encounter difficulties for so doing, as only the modesty of Röntgen and the Curies was able to prevent it.

We find proof of Röntgen's modesty all through the history of his life, before and after the discovery. Who does not remember that, when honored by the king of Bavaria with a decoration and the title of Noble for himself and his descendants,

he rejected that title, which any other would have accepted eagerly. And on reading his first communication "On a New Kind of Ray" does one not perceive the modest man from beginning to end?

Modesty in dress, in attitude, in scientific communications. Modesty in rejecting the most highly merited honors. And modesty in feeling, in thought and in deed. Therein lie the reasons for the exaltation of Röntgen in the eyes of his contemporaries and of posterity. The greatness of a man of science runs parallel to his modesty. If this latter is wanting there is no risk in affirming that the scientific greatness is only apparent and will crumble easily with the passing of time.

A taste for art and comfort in living was acquired by Röntgen even when he was small, as at his home in Holland he could breathe just such an atmosphere surrounded by true works of art originating from his ancestors. In 1866, when he entered the Technical School of Utrecht for the study of algebra, geometry, physics and chemistry, he was only seventeen years of age. It was the period in which he was in the habit of enjoying the country on horseback and skating, and by making long and frequent trips to the surroundings of the city. And it was there that he made the friendship of a companion whom he liked and admired, not only because of his true and loyal friendship, but also because of his great talent as a draftsman. This admiration must have been very great, for Röntgen had no special ability for painting or drawing. It was for this reason that one day when his companion was giving the final touches to the admirable and acrimonious caricature which he had made on the screen of the chimney in the classroom and representing one of the least loved and most feared of the teachers, Röntgen was enraptured as he admired it. His friend had time to retire from the room, after finishing what he considered a work of art, and the arrival of the teacher, the object of the caricature, with difficulty shook Röntgen out of his absorption. And no warnings, punishments or threats of more severe punishments sufficed to make him reveal the name of the author of what the person featured considered to be an unpardonable offense. How can we fail to admire in Röntgen's personality that firmness of character which he possessed from his early days and preserved all through his life? Expulsion from the school meant a definite end to his studies, but he preferred to face that with resignation and strength rather than break the rules of gentlemanliness or to impair, even in the most insignificant degree, his vigorous and arrogant personality. Such a noble though youthful characteristic should not be forgotten, because it serves to explain many of his actions in later life. And his firmness of character had to be on a par with a well tried honesty. Each and every one of his scientific communications abounds with honesty. When reading these communications, one cannot imagine, even for a moment, that there is the slightest dissimulation from the real truth. What a contrast they make with those of so many and so well known pseudo-scientists whose experiences and discoveries can be realized on paper only by themselves. As they are lacking in honesty they skip a link in the chain of experimentation for the purpose of obtaining obvious results, inasmuch as other investigators have never been able to corroborate them.

And let us also remember that letter written to Mrs. Boveri the wife of his great and life-long friend. After explaining to her that within fifteen days, and in accordance with a disposition of the German government, he would have to change the money he had in Italy and America for government bonds, and although being in a position to keep those funds without anyone knowing, he ends by saying, with the greatest simplicity, that he went to look for the employee in charge of the corresponding department in order to inform him that within eight days he would make the change, and adds: "I had great difficulty in convincing him that I had no intention to defraud the state." Neither could the

employee understand such honesty, nor could Röntgen think for a moment of not fulfilling an obligation towards his own conscience and his country.

Honesty and firmness of character should be congenital qualities of man. A beautiful utopia which we most certainly shall not see converted into a reality in the present century and perhaps not in the forthcoming ones. Those who possess it will continue to be select individuals and will be the pride of their race and title.

On December 28, 1895, Röntgen delivered what he called a "Preliminary Communication on a New Kind of Rays." It contains ten pages in which are recorded seventeen experimental facts on the rays discovered by him fifty days before. One does not know what to admire more: the unlimited capacity of a work which he executed, without interruption, during fifty days and nights, as his pauses for food and sleep were insignificant; or the privileged intelligence and exceptional gift of observation which permitted him to establish new and fundamental scientific facts which have preserved their reality and are today as positive as they were fifty years ago.

Untiring steadiness, privileged intelligence, a gift of observation and excessive love of work, combined with learning in the field of physics which was unusual to that period, had to make a real sage of Röntgen. But not even these intellectual conditions, nor those inflexible moral principles of which I have spoken, sufficed to make Röntgen the discoverer of the x-rays. It was necessary tor him to have, in addition, that intangible and, to my way of thinking, supernatural something which has always been an exclusive privilege of a very few, and which we call "genius." Röntgen, in order to make such a prodigious discovery had to be, as he actually was, a *genius*.

And since he was a genius, can we accept his discovery as being the result of mere accident? By no means. It was the culmination of a series of studies and investigations carried out by Röntgen and also by other scientists previously. From the year 600 B.C., in which Tales of Mileto discovered the first phenomenon of electricity on rubbing a piece of amber, till the discovery of the roentgen ray, we find an innumerable number of investigators who, step by step, caused science to advance in the field of electricity.

William Gilbert, who lived from 1540 to 1603, can be considered as the father of electricity. He discovered terrestrial magnetism and used, for the first time, the term "electricity," from the Greek word for amber.

From 1602 to 1691, Torricelli, von Guericke, Schott and Boyle succeeded in forming a vacuum in closed receptables, and studied some of the phenomena that took place there. Newton, Hawksbee, Gray and DuFay, from 1643 to 1739 were already working with machines producing electricity; they studied the sparks and the conduction of electricity by means of metal wires, and they marked two kinds of electricity: the vitreous and the resinous. The Abbé Nollet, Franklin, Galvani, Volta, Oerstedt, Ampère, Ohm and Faraday, between 1700 and 1867, produced electrical and luminous phenomena in the inside of tubes filled with thin air, studied atmospherical electricity, observed the muscular reactions in a frog when subjected to electric current, discovered dry cells, demonstrated the variation of the magnetic needle by electricity and the laws that governed it, pointed out electrostatic induction, and completed the studies on electrical discharges in vacuo. And finally, Hertz, Geissler, Hittorf and Crookes, towards the end of the last century amplified and perfected both the electrical and the luminous phenomena observed in the tubes when subjected to electrical currents, which opened the way to Röntgen for the discovery of the x-rays which were potential in previous discoveries.

And now let us consider for a moment the contributions which roentgen rays have made to medicine in the field of diagnosis and treatment.

We have almost forgotten the incidents that occurred so frequently at the great medical consultations held during the latter part of the last century. The vehemence of every clinician in defense of his viewpoints was such that he seemed more as if he were attending a scientific duel than being in the presence of scientific men seeking the welfare of their patients. The refined observation, the profound clinical experience and the gift of analysis and synthesis of the physicians of that time were much greater than we can imagine. But, unfortunately, there was no way, in many instances, of knowing which of the varied opinions was the right one. Very often the discussions continued on after the death of the patient. The calmness that reigns today in all medical consultations and the minimum vehemence in opinions are due solely to the fact that the laboratory and the roentgen ray, but chiefly the latter, contribute so many positive and certain proofs that they eliminate all impassioned discussions. The clinic has been, and will continue to be in the future, the basis and the support of medical studies. But roentgen rays have given so much and such valuable service, that no one would think of dispensing with a roentgenographic examination as a complement to a clinical study. Just as we would not think of using today the vehicles of the latter half of the last century, because what was then protective sluggishness is now discordant to the age in which we live, so also it would be out of place to use the same slow clinical methods of those times for a diagnosis, even though it be precise.

It is sufficient to mention the different branches of medicine in order to appreciate the priceless help that roentgen rays are giving to clinical diagnosis today.

Permit me to mention some of the roentgenographic examinations made, and some of the facts relating to them, which I think should not be forgotten.

Orthopedics has attained its present stage thanks to roentgenography.

Examination of the digestive organs has not only facilitated a study of the structure of mucosa but it provides for a diagnosis which a microscopical examination is unable to prove. The same occurs in the case of incipient gastric cancer which Guttman has taught us to discover roentgenographically, and which this Congress is studying as one of its main subjects.

In a roentgenographic study of the urinary system we have learned physiological rudiments that were unknown before, such as the paralyzation of the functions of a kidney in certain cases of calculous obstructions of the ureter by which means Nature very wisely forestalls the formation of hydronephrosis.

And the eyes of the scientific world can contemplate all the improvements attained in the diagnosis of the injuries to the nervous system, the heart, the veins, the arteries, the joints, and so forth, whether ordinary methods are employed or whether on occasions biopsies are sought.

And in the study of the thorax for the diagnosis of pleuropulmonary diseases, I should like to refer to the work of a Latin-American, my dear friend and colleague, Manuel D'Abreu. Ten years ago roentgen photography, or abreuography, as we should call it, was endeavoring, with great difficulty, to find a way into the field of science. The tenacity and energy of Manuel D'Abreu were necessary for convincing the hygienists, little by little, what a collective examination meant, in low cost, in tuberculosis case finding in large masses of people. Then came the struggle; and today, when we should acknowledge the friend and scientist as the one responsible for the introduction of the method, one only hears of modifications, innovations, reforms and improvements effected in a process of examination considered as antiquated and given to the world by enchantment. As this Congress is considering roentgen photography as one of its principal themes, I have thought it fair and natural that we pay to our esteemed friend Manuel D'Abreu the well deserved tribute of our admiration.

And as I refer now to what has been attained with roentgen rays in the field of therapeutics, I should like to deal, with special emphasis, not on so many and so varied conditions which radiations cure or improve, but solely on the importance of therapeutics in cancer and inflammatory diseases. In the case of the former, because, in spite of the great and clearly accepted success achieved in this field I do not think that either roentgen therapy, curietherapy or surgery is the method which will, in the future, put an end to cancer; in the case of the latter, because the way in which roentgen rays work in cases of infection is exactly the foundation on which, within a few years, the treatment and cure of diseases will be based.

Until we know the exact cause of the cellular disturbance known as cancer, while we have to be attacking cellular insurrections appearing in any part of our organism, without the certainty that this dissociative element has not sent out an exciting agent to some other distant part to provoke a more serious insurrection than the first, we shall never control cancer. We cannot accept as the goal of therapeutics the mere presentation of more or less high percentages of healings and survivals in cases which, had it not been for the treatment, would have been fatal in a short time. The cause of cancer must be found, as it will be—even though it takes a long time—and when this happens, the element or process which will put an end to so dreadful a scourge will come to light. In the meantime roentgen and curie therapists and surgeons must feel proud of having cured or alleviated thousands of cancerous patients who, without their help, would have had no hope of consolation. Let us forge ahead in the perfection of technique and methods for these treatments, because in this way we shall improve on actual results, but let us not be deluded into thinking that radiation and surgery are the weapons with which we can finally conquer cancer. As cures are far more frequent in incipient cases, let us continue to impress upon the public the necessity of undergoing treatment quickly, as thus their probabilities of cure will be greatly increased.

There is great scientific pessimism and a desire for excellence in what I have just expounded, but in no way is it a reason for discouragement on the part of the victims of cancer because cures are increasing daily as patients seek specialists more quickly. We can hardly ask more from a therapist who is struggling against an enemy of whose origin he is completely ignorant.

Although roentgen rays have no direct action on bacteria, such magnificent results have been obtained in the treatment of many inflammatory cases of bacterial origin, that several investigators, led by Heidenhain and Fried devoted their attention to a careful study of the action of roentgen rays on persons irradiated for different illnesses such as sinusitis, mastoiditis, and furunculosis, which have reacted favorably to irradiation. It has been possible to demonstrate that its entire mechanical action was limited to the improvement and increase of the natural defenses against infection. Roentgen rays, administered in small doses, destroy the most vulnerable leukocytic elements which gather in great numbers in the infected part, and thus they liberate the antibodies which they carry for the struggle. But as the attacking elements die the organism sends out new troops of white cells to replace the preceding ones, and finally the moment arrives when the attack is held and the infection defeated. This therapy, as shown by Wintz, provokes an impact in the human body similar in its humoral symptomatology to that produced by foreign substances such as proteins, colloids, and so forth. As in the case of every impact, it produces a sudden change in the colloidal equilibrium of the plasma and is revealed by constant humoral phenomena demonstrated by Wintz in irradiated individuals. There are modifications of the hydrogen ion concentration, delay in the period of coagulation, leukopenia, drop in blood pressure, hyperglycemia, hypervago-

tonia, and so forth. But as it has to do with an impact caused by the very substances of the organism under treatment, it is evident that its therapeutic effect must be better, more effective, and subject to less surprises than if produced by elements that are foreign to the human body. But the effect of roentgen therapy in inflammatory cases also explains its results. Sometimes the cure takes place rapidly; on other occasions it is slow; sometimes its effect is limited to a temporary relief for the patient; and when administered in small doses it is never harmful to the organism. It is logical that it should be so, inasmuch as all that we do is to activate the natural defenses of each of the persons irradiated. The great individual reactions which we find in them will cause the improvement in the patients to be more or less rapid and complete.

The day when therapeutics will be restricted, as is roentgen therapy to inflammatory diseases, to seek the natural health of which Carrel speaks, thus increasing the natural defenses of man, and to struggle against the few diseases which may present themselves in organisms previously well defended, the opinions of humanity on life and disease will be changed completely.

We have often quoted the following providential words of Alexis Carrel, and with which I am in absolute accord. Listen to them:

> As we know, there are two kinds of health—natural and artificial. We covet natural health which comes from the resistance of the tissues to infectious and degenerative diseases, from the equilibrium of the nervous system. And not the artificial health which depends on nourishing diets, serums, endocrinous products, vitamins, periodical medical examinations, and on expensive medical protection, hospitals and nurses. Man ought to have been created in such a way as not to be in need of these cares. Medicine will have attained its greatest triumph when it discovers the manner of ignoring sickness, fatigue and fear. We should give to humanity liberty and happiness resulting from the perfection of organic and mental activities.

On reading the interesting account which Lieutenant Colonel Lewis E. Etter gives of his visit to the Roentgen Laboratory, in Würzburg, after World War II, I have experienced an intense emotion. Two hundred and forty thousand incendiary bombs were hurled on Würzburg on March 16, 1945. The greater part of the city was destroyed but, by nothing less than a miracle, almost the whole of the Institute of Physics and that commemorative plate, which says, in translation, "In this house, in the year 1895, W. C. Röntgen discovered the rays which were named after him," remained intact, whereas the Institute of Anatomy and other neighboring buildings were completely destroyed. This amazing fact convinces us very clearly that Röntgen and his work are above the hatred and the struggles which present themselves periodically between nations.

In the same way, this is being shown by the members of the second Inter-American Congress of Radiology in this tribute. A group of men of science, appertaining to the United Nations, on meeting here today, and who have just ended their struggle against Nazi Germany, have thought it fit to pay tribute to science represented in a genius born in the very Germany which they have just fought.

Just as Röntgen must have suffered in the other world on seeing the sad and erroneous route which his native land had taken in, what was at that time, recent years, today he must feel pride on seeing that in this noble and cordial city of Havana, many of his disciples and admirers have met to seek the same ideals which he sought during his life.

Havana has always been a center of science and medical investigation, not only in the field of radiology, but also in all branches of medicine. It is enough, for today, to quote as illustrious examples of those who continue to carry on his work, the names of some notable Cuban investigators now dead.

Years before the eminent figure of

President Grau San Martin was known as a leader, and before he was admired by the political world, we, the doctors of America, recognized in him the perfect physiologist, the careful investigator and the famous teacher whose teachings had already crossed the borders of the country.

And in Dr. Pedro L. Fariñas, the esteemed President of this Congress, we see the man of science who, like Röntgen, has converted modesty into his most sublime virtue.

As Americans, let us seek the scientific union of all the radiologists in the world, and remembering Röntgen and his work, let us do all that we can to combine the Third Inter-American Congress of Roentgenology and Curietherapy, which will take place in 1949, with the Sixth World Congress, so that we may meet again fraternally, and under the protection and guidance of ideals similar to those of the radiologists of five continents.

My dear companions: let us pray that the science of Roentgenology will continue to be, as a science, the goal of our lives.

THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

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Forty-ninth Annual Meeting: Palmer House, Chicago Ill., Sept. 14–17, 1948.

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Thirtieth Annual Meeting: Stevens Hotel, Chicago, Ill., June 20–22, 1948.

EDITORIALS

THE ANNUAL MEETING OF THE AMERICAN ROENTGEN RAY SOCIETY

THE Forty-ninth Annual Meeting of the American Roentgen Ray Society is to be held at the Palmer House, Chicago, Illinois, September 14–17, 1948. The selection of the Palmer House as a meeting place is an excellent one as the hotel facilities are, as all the members of the Society know, ample to house the Scientific and Technical Exhibits, and the rooms that are available for the Scientific Sessions and the Instruction Courses cannot be surpassed. The Society returns to Chicago with very pleasant memories of the Joint Meeting with the Radiological Society of North America which was held in Chicago in September of 1944.

The program which has been arranged by the Chairman of the Program Committee, President Elect Reynolds and his committee should make an especial appeal to all those attending the meeting. The Program Committee has endeavored to restrict somewhat the number of papers that are being given in order that more general discussion of the papers may be had.

Particular attention is called to the splendid round table discussions and symposiums that have been arranged, as well as to the group of instructive general papers.

The Preliminary Program of the meeting is given elsewhere in this issue of the JOURNAL and it is urged that these pages be read carefully. It can readily be seen that the Program Committee has enlisted the services of some of the leading medical men—internists, surgeons, pathologists and radiologists—and the symposium dealing with radiobiology in its relation to radiology is unsurpassed not only in the timeliness of the discussion of such an important subject, but the participants in the program are outstanding in their respective fields.

The Caldwell Lecture—this year on Wednesday evening—will be given by Dr. B. R. Kirklin, Chief of the Section of Roentgenology, Mayo Clinic; Director of the Division of Radiology and Professor of Radiology, Mayo Foundation Graduate School, University of Minnesota, Rochester, Minnesota. Dr. Kirklin needs no introduction to the medical or radiological world. The topic which Dr. Kirklin has chosen—"Graduate Education in Roentgenology"—is of great importance to the medical profession and there is no one who is better equipped to discuss this phase of roentgenology,

The Instruction Courses this year are under the directorship of Dr. Harry M. Weber. These courses are always an important feature of the annual meetings and the splendid courses which have been arranged by Dr. Weber are published elsewhere in this issue of the JOURNAL. Since the number who may attend these courses is limited it is urged that those who anticipate taking these courses fill out the order blank at once.

The Chairman of the Scientific Exhibit Committee, Dr. Wilbur Bailey, and his committee have arranged a superb exhibit, many of the scientific exhibits amplifying and extending the papers that are to be given in the Scientific Program.

The Technical Exhibit which is always of importance to the annual meetings is this year the largest that the Society has ever had and should provoke a great deal of interest. The Program Committee has

allotted a sufficient time during the morning and afternoon for viewing the Scientific and Technical Exhibits.

The social functions of the meeting have not been neglected. The Annual Banquet, with well chosen entertainment, is to be held on Thursday evening and the Ladies Entertainment Committee has arranged an excellent and varied program for the visiting ladies.

The forthcoming meeting in Chicago should stimulate much interest and should attract a large number of radiologists, and in view of this fact it is urged that all who anticipate attending the meeting make their reservations with the Palmer House at the earliest possible moment.



ALFRED FRANKLIN HOCKER
1902–1948

ALFRED FRANKLIN HOCKER, a member of the American Radium Society, died suddenly at his home at 14 East 90th Street, New York, on February 12, 1948, of a coronary thrombosis.

On the day preceding his death he had followed his usual routine; he had performed an operation in the morning, worked in the Out-Patient clinic at Memorial Hospital and in his office in the afternoon. In the evening, he had attended the theater with his wife and friends and his death occurred suddenly, shortly after midnight.

Dr. Hocker, mainly of Swiss ancestry, was born on April 20, 1902, in Audubon, Iowa, the son of Franklin Pierce Hocker and Ida (Sauer) Hocker. When he was four years old the family moved to El Reno, Oklahoma, where he attended and graduated from the public schools. In 1920 he enrolled in the College of Liberal Arts at the University of Oklahoma, and in 1922 he began the study of medicine at the University of Louisville Medical School, receiving the degree of Doctor of Medicine in 1926. After an internship of eighteen months in the Louisville City Hospital and two years of general practice in El Reno, he was appointed an intern at the Memorial Hospital in New York in January, 1931. In July, 1931, he began a three year service as a Rockefeller Fellow in Cancer Research at the Memorial Hospital, finishing in July, 1934, with a year's service as Resident Surgeon.

In 1934 he began the practice of medicine as a specialist in the treatment of cancer by surgery and radiation and his staff appointments during his early years of practice were: Assistant Professor of Radiology at Cornell University, Assistant Surgeon in Otolaryngology at New York Hospital, Consulting Radiologist, New York Hospital, Associate Radiologist at the Memorial Hospital and at the White Plains Hospital. In 1936 he took an active part in the establishment of a tumor clinic at the Cornwall (New York) Hospital and soon became its Director, a position which he held until the time of his death. In 1941 his appointment at Memorial Hospital was changed to Assistant Attending Surgeon assigned to the Head and Neck Service. Although he maintained a country home at St. James on the North Shore of Long Island, he nevertheless devoted nearly every Saturday to his tumor clinic at Cornwall, time which he might otherwise have spent in restful relaxation in the country with his family and friends.

During his whole professional life he limited his practice to the treatment of neoplastic diseases. Though a thoroughly trained and active surgeon, he maintained an equal interest in radiation therapy wherever indicated in the treatment of neoplastic diseases, and did much to standardize irradiation techniques. Among his contributions to the science of cancer therapy was the development (in collaboration) of a technique for sialography in the diagnosis of tumors of the major salivary glands. He was the clinical member of the Committee for the Study of Radioactive Isotopes in the Treatment of Thyroid Cancer at Memorial Hospital.

Dr. Hocker was a Fellow of the American College of Surgeons, a Diplomate of the American Board of Radiology, a member of the American College of Radiology, American Medical Association, American Radium Society, New York Roentgen Ray Society, and the New York Academy of Medicine.

In 1932 he married Margaret Summers Lane of Richmond, Kentucky, and a son, Alfred Franklin Hocker, Jr. was born in 1936. He is survived by his wife and son, his mother, Mrs. Franklin Pierce Hocker of El Reno, and a brother, Carl Hocker of Seattle.

Al Hocker died a relatively young man but he had lived a full, useful, and busy life. His death came as most doctors would prefer it, after a busy day when he had followed his usual active routine, in the operating-room, the clinic, and his office. His medical colleagues, both at Memorial Hospital and throughout the United States were deeply saddened by his untimely death. The universal esteem and affection which he inspired among those who knew him can perhaps be expressed here, though somewhat inadequately, in the words of a resolution passed by the Medical Board of the Memorial Hospital, which reads as follows:

"At its regular meeting on April 6, 1948, the Medical Board resolves that the Memorial Hospital has suffered an irreparable loss in the sudden death of Dr. Alfred Franklin Hocker, one of the most beloved and widely respected members of its staff.

"Only in retrospect can one begin to ap-

preciate the scope and the depth of his influence upon us, his associates, and upon the institution as a whole. Wherever Al Hocker lived and moved the atmosphere of human relations was bound to be more friendly under the force of his warm and generous personality. His kindliness and sympathetic understanding inspired an immediate and lasting affection in all those with whom he came in contact. He was generous and tolerant in his judgments of others, and modest in his opinion of his own achievements. He took no part or side in minor disagreements. The universal esteem and affection which he possessed inspired many of his associates to emulate, in some degree, his unselfish and generous example. His work will be taken up and carried on by others, but the death of Al Hocker leaves a void in the hearts of his many friends and patients which can never be filled."

HAYES MARTIN

SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

Items for this section solicited promptly after the events to which they refer

MEETINGS OF ROENTGEN SOCIETIES*

UNITED STATES OF AMERICA

AMERICAN ROENTGEN RAY SOCIETY
Secretary, Dr. H. Dabney Kerr, University Hospital, Iowa City, Iowa. Annual meeting: Palmer House, Chicago, Ill., Sept. 14–17, 1948.

AMERICAN RADIUM SOCIETY
Secretary, Dr. H. F. Hare, 605 Commonwealth Ave., Boston, Mass. Annual meeting: *1949, to be announced.*

RADIOLOGICAL SOCIETY OF NORTH AMERICA
Secretary, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N. Y. Annual meeting: Hotels Fairmont and Mark Hopkins. San Francisco, Calif., Dec. 5–10, 1948.

AMERICAN COLLEGE OF RADIOLOGY
Secretary, Mac F. Cahal, 20 N. Wacker Drive, Chicago 6. Annual meeting: 1949, to be announced.

SECTION ON RADIOLOGY, AMERICAN MEDICAL ASSOCIATION
Secretary, Dr. U. V. Portmann, Cleveland Clinic, Cleveland, Ohio, Annual Meeting: *1949, to be announced.*

ALABAMA RADIOLOGICAL SOCIETY
Secretary, Dr. C. S. Stickley, 515 Bell Bldg., Montgomery, Ala. Next meeting time and place of Alabama State Medical Association.

ARKANSAS RADIOLOGICAL SOCIETY
Secretary, Dr. Fred Hames, 511 National Bldg., Pine Bluff, Ark. Meets every three months and also at time and place of State Medical Association.

BROOKLYN ROENTGEN RAY SOCIETY
Secretary, Dr. A. H. Levy, 1354 Carroll St., Brooklyn 13, N. Y. Meets monthly on fourth Tuesday, October to April.

BUFFALO RADIOLOGICAL SOCIETY
Secretary, Dr. Mario C. Gian, 610 Niagara St., Buffalo, N. Y. Meets second Monday evening each month, October to May inclusive.

CENTRAL NEW YORK ROENTGEN RAY SOCIETY
Secretary, Dr. Dwight V. Needham, 608 E. Genesee St., Syracuse, N. Y. Three meetings a year January, May, November.

CENTRAL OHIO RADIOLOGICAL SOCIETY
Secretary, Dr. Paul D. Meyer, Grant Hospital, Columbus, Ohio. Meets at 6:30 P.M. on second Thursday of October, December, February, April, and June at Seneca Hotel, Columbus, Ohio.

CHICAGO ROENTGEN SOCIETY
Secretary, Dr. T. J. Wachowski, 310 Ellis Ave., Wheaton, Ill. Meets second Thursday of each month October to April inclusive at the Palmer House.

CINCINNATI RADIOLOGICAL SOCIETY
Secretary, Dr. Eugene L. Saenger, 735 Doctors Bldg., Cincinnati 2, Ohio. Meets last Monday of each month, September to May, inclusive.

CLEVELAND RADIOLOGICAL SOCIETY
Secretary, Dr. George L. Sackett, 10515 Carnegie Ave. Cleveland 6, Ohio. Meetings at 6:30 P.M. on fourth Monday of each month from October to April.

DALLAS-FORT WORTH ROENTGEN STUDY CLUB
Secretary, Dr. X. R. Hyde, Medical Arts Bldg., Fort Worth, Texas. Meets in Dallas on odd months and in Fort Worth on even months, on third Monday, 7:30 P.M.

DENVER RADIOLOGICAL CLUB
Secretary, Dr. Mark S. Donovan, 306 Majestic Bldg., Denver 2, Colo. Meets third Friday of each month at Department of Radiology, Colorado School of Medicine.

DETROIT ROENTGEN RAY AND RADIUM SOCIETY
Secretary, Dr. E. R. Witwer, Harper Hospital. Meets monthly on first Thursday from October to May, at Wayne County Medical Society Building.

FLORIDA RADIOLOGICAL SOCIETY
Secretary, Dr. J. A. Beals, St. Luke's Hospital, Jacksonville, Fla. Meets twice yearly, in April preceding annual meeting of Florida Medical Society, and in November.

GEORGIA RADIOLOGICAL SOCIETY
Secretary, Dr. Robert Drane, DeRenne Apartments, Savannah, Ga. Meets in mid-winter and at annual meeting of Medical Association of Georgia in the spring.

HOUSTON X-RAY CLUB
Secretary, Dr. Curtis H. Burge, 3020 San Jacinto St., Houston 4, Texas. Meets fourth Monday each month.

RADIOLOGICAL SOCIETY OF KANSAS CITY
Secretary, Dr. Arthur B. Smith, 800 Argyle Bldg., Kansas City, Mo. Meets third Thursday of each month.

ILLINOIS RADIOLOGICAL SOCIETY
Secretary, Dr. Wm. DeHollander, St. John's Hospital, Springfield, Ill. Meets three times a year.

INDIANA ROENTGEN SOCIETY
Secretary, Dr. J. A. Campbell, Indiana University Hospitals, Indianapolis 7. Meets second Sunday in May.

IOWA X-RAY CLUB
Secretary, Dr. Arthur W. Erskine, 326 Higley Bldg., Cedar Rapids, Iowa. Luncheon and business meeting during annual session of Iowa State Medical Society. Special meetings by announcement.

KANSAS RADIOLOGICAL SOCIETY
Secretary, Dr. Anthony F. Rossitto, Wichita Hospital, Wichita, Kansas. Meets annually with the State Medical Society.

KENTUCKY RADIOLOGICAL SOCIETY
Secretary, Dr. W. C. Martin, 321 W. Broadway, Louisville. Meets annually in Louisville on first Saturday in Apr.

LONG ISLAND RADIOLOGICAL SOCIETY
Secretary, Dr. Marcus Wiener, 1430-48th St., Brooklyn, N. Y. Meets Kings County Med. Soc. Bldg. monthly on fourth Thursday, October to May, 8:45 P.M.

LOS ANGELES RADIOLOGICAL SOCIETY
Secretary, Dr. Moris Horwitz, 441 No. Camden Drive, Beverly Hills, Calif. Meets second Wednesday each month at Los Angeles County Medical Assn. Building.

LOUISIANA RADIOLOGICAL SOCIETY
Secretary, Dr. J. R. Anderson, 1130 Louisiana Ave., Shreveport. Meets annually during Louisiana State Medical Society Meeting.

LOUISVILLE RADIOLOGICAL SOCIETY
Secretary, Dr. E. L. Pirkey, Louisville General Hospital, Louisville 2, Ky. Meets monthly on second Friday at Louisville General Hospital.

MICHIGAN ASSOCIATION OF ROENTGENOLOGISTS
Secretary, Dr. R. D. McDuff, 220 Genesee Bank Bldg., Flint 3, Mich.

MILWAUKEE ROENTGEN RAY SOCIETY
Secretary, Dr. C. A. H. Fortier, 231 W. Wisconsin Ave.,

* Secretaries of societies not here listed are requested to send the necessary information to the Editor.

Milwaukee, Wis. Meets monthly on second Monday at University Club.

Minnesota Radiological Society
Secretary, Dr. Chauncey N. Borman, 802 Medical Arts Bldg., Minneapolis 2, Minn. Two meetings yearly, one at time of Minnesota State Medical Association the other in the fall.

Nebraska Radiological Society
Secretary, Dr. Ralph C. Moore, Nebraska Methodist Hospital, Omaha 3, Nebr. Meets third Wednesday of each month, at 6 P.M. at either Omaha or Lincoln.

New England Roentgen Ray Society
Secretary, Dr. George Levene, Massachusetts Memorial Hospitals, Boston, Mass. Meets monthly on third Friday, Boston Medical Library.

New Hampshire Roentgen Ray Society
Secretary, Dr. A. C. Johnston, Elliott Community Hospital, Keene, N. H. Meets four to six times yearly.

New York Roentgen Society
Secretary, Dr. Ramsay Spillman, 115 East 61st St., New York City. Meets monthly on third Monday, New York Academy of Medicine, at 8:30 P.M.

North Carolina Radiological Society
Secretary, Dr. J. E. Hemphill, 323 Professional Bldg., Charlotte 2, N. C. Meets in May and October.

North Dakota Radiological Society
Secretary, Dr. C. O. Heilman, 807 Broadway, Fargo. Meetings held by announcement.

Northern California Radiological Club
Secretary, Dr. C. E. Grayson, Medico-Dental Bldg., Sacramento 14, Calif. Meets at dinner last Monday, every second month, except June, July and August. Next meeting Sept. 27, 1948.

Ohio State Radiological Society
Secretary, Dr. Carroll C. Dundon, 2065 Adelbert Road, Cleveland 6, Ohio.

Oklahoma State Radiological Society
Secretary, Dr. W. E. Brown, Tulsa, Okla. Three regular meetings annually.

Oregon Radiological Society
Secretary, Dr. William Y. Burton, 242 Medical Arts Bldg., Portland 5, Oregon. Meets monthly 2nd Wednesday, 8:00 P.M., Library of University of Oregon Medical School.

Orleans Parish Radiological Society
Secretary, Dr. Joseph V. Schlosser, Charity Hospital, New Orleans 13, La. Meets first Tuesday of each month.

Pacific Northwest Radiological Society
Secretary, Dr. S. J. Hawley, 1320 Madison St., Seattle 4, Wash. Meets annually in May.

Pacific Roentgen Society
Secretary, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association.

Pennsylvania Radiological Society
Secretary, Dr. J. M. Converse, 416 Pine St., Williamsport.

Philadelphia Roentgen Ray Society
Secretary, Dr. Arthur Finkelstein, Graduate Hospital, 19th and Lombard St. Meets first Thursday each month October to May, at 8:00 P.M., in Thomson Hall, College of Physicians.

Pittsburgh Roentgen Society
Secretary, Dr. R. P. Meader, 4002 Jenkins Arcade Pittsburgh 22, Pa. Meets 6:30 P.M. at Webster Hall Hotel on second Wednesday each month, October to May inclusive.

Queens Roentgen Ray Society
Secretary, Dr. J. E. Goldstein, 88-29 163rd St., Jamaica 3, N. Y. Meets fourth Monday of each month except during the summer.

Radiological Section, Baltimore Medical Society
Secretary, Dr. Harry A. Miller, 2452 Eutaw Place, Baltimore. Meets third Tuesday each month, September to May.

Radiological Section, Connecticut Medical Society
Secretary, Dr. Robert M. Lowman, Grace-New Haven Community Hospital, New Haven 11. Meets bimonthly second Thursday, at place selected by Secretary.

Radiological Section, District of Columbia Medical Society
Secretary, Dr. A. A. J. Den, 1801 K St., N. W., Washington, D. C. Meets Medical Society Auditorium, third Thursday, January, March, May, October at 8:00 P.M.

Radiological Section, Southern Medical Association
Secretary, Dr. Roy G. Giles, Temple, Texas.

Radiological Society of New Jersey
Secretary, Dr. Raphael Pomeranz, 31 Lincoln Park, Newark, N. J. Meets annually at time and place of State Medical Society. Mid-year meetings at place chosen by president.

Rochester Roentgen Ray Society, Rochester, N. Y.
Secretary, Dr. Murray P. George, Strong Memorial Hospital. Meets monthly on third Monday from October to May, inclusive, 8 P.M. at Strong Memorial Hospital.

Rocky Mountain Radiological Society
Secretary, Dr. Maurice D. Frazer, 1037 Stuart Bldg., Lincoln, Nebr. Meets Salt Lake City, Utah, at Hotel Utah, Aug. 12, 13, 14, 1948.

St. Louis Society of Radiologists
Secretary, Dr. Edwin C. Ernst, Beaumont Medical Building, St. Louis, Mo. Meets fourth Wednesday of each month, except June, July, August, and September.

San Diego Roentgen Society
Secretary, Dr. R. F. Niehaus, 1831 Fourth Ave., San Diego, Calif. Meets monthly, first Wednesday at dinner.

Section on Radiology, California Medical Association
Secretary, Dr. D. R. MacColl, 2007 Wilshire Blvd., Los Angeles 5, Calif.

Section on Radiology, Illinois State Medical Society
Secretary, Dr. Edwin L. Rypins, 427 N. Main St., Bloomington, Ill.

Shreveport Radiological Club
Secretary, Dr. R. W. Cooper, Charity Hospital, Shreveport, La. Meets monthly on third Wednesday, at 7:30 P.M., September to May inclusive.

South Carolina X-Ray Society
Secretary, Dr. T. A. Pitts, Baptist Hospital, Columbia, S. C. Meets in Charleston on first Thursday in November, also at the time and place of South Carolina State Medical Association.

Tennessee Radiological Society
Secretary, Dr. J. M. Frère, 707 Walnut St., Chattanooga, Tenn. Meets annually at the time and place of the Tennessee State Medical Association.

Texas Radiological Society
Secretary, Dr. R. P. O'Bannon, 650 Fifth Ave., Fort Worth 4, Texas.

University of Michigan Department of Roentgenology Staff Meeting
Meets each Monday evening from September to June, at 7 P.M. at University Hospital.

University of Wisconsin Radiological Conference
Secretary, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis. Meets first and third Thursdays 4:00 to 5:00 P.M., September to May inclusive. Room 203, Service Memorial Institute, 426 N. Charter St., Madison.

Utah Radiological Conference
Secretary, Dr. Henry H. Lerner, School of Medicine, University of Utah, Salt Lake City 1. Meets 1st and 3rd Thursdays monthly from 7:30 to 10 P.M., Salt Lake County General Hospital, September to June.

Utah State Radiological Society
Secretary, Dr. M. Lowry Allen, Judge Bldg., Salt Lake City 1, Utah. Meets third Wednesday in September, November, January, March and May.

Virginia Radiological Society
Secretary, Dr. P. B. Parsons, Norfolk General Hospital, Norfolk, Va. Meets annually in October.

Washington State Radiological Society
Secretary, Dr. Homer V. Hartzell, 310 Stimson Bldg., Seattle 1, Wash. Meets fourth Monday each month, October through May, College Club, Seattle.

X-Ray Study Club of San Francisco
Secretary, Dr. Ivan J. Miller, 2000 Van Ness Ave. Meets monthly on third Thursday at 7:45 P.M., first six months of year at Lane Hall, Stanford University Hospital, and second six months at Toland Hall, University of California Hospital.

Cuba

Sociedad de Radiología y Fisioterapia de Cuba
President, Dr. J. Manuel Viamonte, Hospital Mercedes, Habana, Cuba. Meets monthly in Habana.

Mexico

Sociedad Mexicana de Radiologia y Fisioterapia
General Secretary, Dr. D. P. Cossio, Marsella No. 11, Mexico, D. F. Meets first Monday of each month.

British Empire

British Institute of Radiology Incorporated with the Roentgen Society
Medical Members' meeting held monthly on third Friday at 2:30 P.M. and Ordinary Meeting at same time on following Saturday, October to May, 32 Welbeck St., London, W.1.

Faculty of Radiologists
Secretary, Dr. M. H. Jupe, 23 Welbeck St., London, W.1 England.

Section of Radiology of the Royal Society of Medicine (Confined to Medical Members)
Meets third Friday each month at 4:45 P.M. at the Royal Society of Medicine, 1 Wimpole St., London.

Canadian Association of Radiologists
Honorary Secretary, Dr. E. M. Crawford, 2100 Marlowe Ave., Montreal 28, Que. Meetings January and June.

Section of Radiology, Canadian Medical Association
Secretary, Dr. C. M. Jones, Inglis St., Ext. Halifax, N. S.

Société Canadienne-Francaise d'Electrologie et de Radiologie Médicales
Secretary, Dr. Origéne Dufresne, 4120 Ontario St., East, Montreal, P. Q.

Australian and New Zealand Association of Radiologists
Honorary Secretary, Dr. Alan R. Colwell, 135 Macquarie St., Sydney, N.S.W.
Honorary Secretaries, State Branches:
New South Wales, Dr. E. W. Frecker, 135 Macquarie St., Sydney.
Victoria, Dr. T. L. Tyrer, 3 Lockerbie Court, East St. Kilda.
Queensland, Dr. J. Adam, 131 Wickham Terrace, Brisbane.
South Australia, Dr. B. C. Smeaton, 178 North Terrace, Adelaide.
Western Australia, Dr. A. M. Nelson, 179-B St. Georges Terrace, Perth.
New Zealand, Dr. E. G. Lynch, 12 Bolton St., Wellington.

South America

Sociedad Argentina de Radiologia
Secretary, Dr. Guido Gotta, Buenos Aires, Argentina. Meetings are held monthly.

Sociedade Brasileira de Radiologia Medica
Secretary, Dr. Nicola Caminha, Av. Mem de Sa, Rio de Janeiro, Brazil. Meets monthly, except during January, February and March.

Sociedade Brasileira de Radioterapia
Secretary, Dr. Andrelino Amaral, Av. Brigadeiro Luiz Antonio, 644, São Paulo, Brazil. Meets monthly on second Tuesday at 9 P.M. in São Paulo at Av. Brigadeiro Luiz Antonio, 644.

Sociedad Peruana de Radiologia
Secretary, Dr. Julio Bedoya Paredes, Apartado, 2306 Lima, Peru. Meetings held monthly except during January, February and March, at the Asociación Médica Peruana "Daniel A. Carrión," Villalta, 218, Lima.

Continental Europe

Société Belge de Radiologie
General Secretary, Dr. S. Masy, 111 Avenue des Alliés, Louvain, Belgium. Meets monthly, second Sunday at Maison des Médecins, Brussels.

Ceskoslovenská společnost pro röntgenologii a radiologii v Praze
Secretary, Dr. Roman Bláha, Praha XII, stát. nemocnice, Czechoslovakia. Meets monthly except during July, August, and September. Annual general meeting.

Polish Society of Radiology
Secretary, Dr. L. Zgliczynski, 59 Nowogrodzka St., Warsaw, Poland. Next meeting May 13 and 14, 1948.

Gdansk Section, Polish Society of Radiology
Secretary, Dr. A. Smigielska, Akademia Lekarska, Gdansk. Meets monthly last Sunday at 10.30, X-Ray Dept., Akademia Gdansk.

Warsaw Section, Polish Society of Radiology
Secretary, Dr. L. Zgliczynski, 59 Nowogrodzka St., Warsaw, Poland. Meets monthly.

Societatea Romana de Radiologie si Electrologie
Secretary, Dr. Oscar Meller, Str. Banual Mărăcine, 30, S. I., Bucuresti, Roumania. Meets second Monday in every month with the exception of July and August.

All-Russian Roentgen Ray Association, Leningrad. USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.
Secretaries, Drs. S. A. Reinberg and S. G. Simonson. Meets annually.

Leningrad Roentgen Ray Society
Secretaries, Drs. S. G. Simonson and G. A. Gusterin. Meets monthly, first Monday at 8 o'clock, State Institute of Roentgenology and Radiology, Leningrad.

Moscow Roentgen Ray Society
Secretaries, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky. Meets monthly, first Monday, 8 P.M.

Scandinavian Roentgen Societies
The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association.

Sociedad Espanola de Radiologia y Electrologia
Secretary, Dr. J. Martin-Crespo, Fuencarral, 7. Madrid, Spain. Meets monthly in Madrid.

Schweizerische Röntgen-Gesellschaft (Société Suisse de Radiologie)
President, Dr. H. E. Walther, Gloriastr. 14, Zürich, Switzerland.

ROCKY MOUNTAIN RADIOLOGICAL SOCIETY MEETING, SALT LAKE CITY, UTAH, AUGUST 12, 13, 14, 1948

The tenth mid-summer conference of the Rocky Mountain Radiological Society will be held at the Hotel Utah in Salt Lake City, Utah, on August 12, 13 and 14, 1948. The program includes the following guest speakers:

John D. Camp, M.D., Rochester, Minnesota: "Sources of Error in Encephalography and Ventriculography"; "Significant Roentgenologic Findings in Intracranial Disease."

Ross Golden, M.D., New York City, N. Y.: "Some Problems Connected with the Detection of Carcinoma of the Stomach"; "Disturbances in the Small Intestine Connected with Disease of the Mesentery."

John Caffey, M.D., New York City, N. Y.: "Congenital Obstructions of the Alimentary Tract"; "Two New Syndromes of Growing Bone."

Wendell G. Scott, M.D., St. Louis, Missouri: "Importance of Early Diagnosis of Carcinoma of the Colon"; "Low Back Pain and the Evaluation of Radiographic Methods of Diagnosis."

Juan A. del Regato, M.D., Columbia, Missouri: "Treatment of Carcinoma of the Lower Lip"; "Transvaginal Roentgen Therapy for Carcinoma of the Cervix."

L. Henry Garland, M.D., San Francisco, California: "Sarcoidosis of Boeck."

On the evening of August 12 there will be a joint meeting of the Society with the Salt Lake County Medical Society, to be followed by a Dutch Lunch. The annual banquet will be held in the Lafayette Ballroom of the Hotel Utah on the evening of August 13. The toastmaster will be Mac F. Cahal, Secretary of the American College of Radiology, and the principal speaker will be Dr. Henry Garland. Other entertainment features include a sight-seeing trip around Salt Lake City and a trip by bus to the great Bingham Copper Mine and the Great Salt Lake. The meeting will conclude on the afternoon of August 14 with an outdoor steak dinner at Maxfields Lodge in Big Cottonwood Canyon. All Radiologists are cordially invited to attend this meeting and participate in the proceedings.

COURSE IN APPLICATION OF NUCLEAR PHYSICS

The University of California in cooperation with the University Medical Schools at Los Angeles and San Francisco will present a course in "The Application of Nuclear Physics to the Biological and Medical Sciences," to be given at the University of California at Los Angeles, August 2 through August 20, 1948, under the auspices of Medical Extension. Seventeen officers of instruction will give the courses.

General Chairman: Stafford L. Warren, M.D., Professor of Biophysics and Dean of the School of Medicine, University of California, Los Angeles.

Director of Course: Fred A. Bryan, M.D., Associate Clinical Professor of Medicine, School of Medicine, University of California, Los Angeles.

Director of Laboratory: D. Harold Copp, Ph.D., M.D., Assistant Professor of Physiology, University of California, Berkeley.

The tuition fee for the complete course, including laboratory training, is $350.00. Tuition fee for the lecture series alone is $100.00. Enrollment in this course is limited, and applicants must present biographical data for approval by a Committee on Admissions.

Further information concerning housing facilities, etc., will be available upon request. All communications should be addressed to S. J. Weinberg, M.D., Head of Postgraduate Instruction, Medical Extension, University of California, Los Angeles 24, California.

CENTRAL OHIO RADIOLOGICAL SOCIETY

At a recent meeting of the Central Ohio Radiological Society, completing its second year, Dr. Thurman R. Fletcher was elected President and Dr. Paul D. Meyer Secretary-Treasurer. A number of interesting talks had been given at the various meet-

ings held during the year by guest speakers including Dr. Harry M. Weber of the Mayo Clinic, Dr. Samuel Brown, Dr. Brent Wayman and Dr. Ben Felson, all of Cincinnati, and Dr. Merthyn A. Thomas of Cleveland.

NORTHERN CALIFORNIA RADIOLOGICAL CLUB

The Northern California Radiological Club has been organized for a period of one year and meets at dinner the last Monday in every second month except June, July and August. The next meeting will be held on September 27, 1948. The Secretary of the Club is Dr. Charles E. Grayson, Medico-Dental Building, Sacramento 14, California.

OKLAHOMA STATE RADIOLOGICAL SOCIETY

The Oklahoma State Radiological Society held its meeting on Mary 17, 1948, at the Skirvin Hotel, Oklahoma City, Oklahoma. The guest at the meeting was Dr. L. H. Garland, of San Francisco. The newly elected officers of the Society are: *President*, Dr. P. E. Russo; *Vice-President*, Dr. H. B. Yagol; *Secretary-Treasurer*, Dr. W. E. Brown.

TENNESSEE RADIOLOGICAL SOCIETY

At the recent annual meeting of the Tennessee Radiological Society Dr. A. N. Arneson, of St. Louis, and Mr. Mac F. Cahal, Executive Secretary of the American College of Radiology were guests. The following officers were elected for the coming year: *President*, Dr. Franklin B. Bogart, Chattanooga; *Vice-President*, Dr. Herbert Francis, Nashville; and *Secretary-Treasurer*, Dr. J. Marsh Frère, Chattanooga.

To the Editor:

Since the publication of the paper "Two Danish Photofluorographic Cameras of the Original Schmidt Type," in the March, 1948, issue of the AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY, our attention has been called to the fact that Dr. Helge Christensen of Copenhagen and not the Danish engineer Helm, was responsible for the initial work involved in the production of the cameras described in the paper. Dr. Christensen has informed us that his work on the application of Schmidt optics to photofluorography began in 1938 and it was not until later in 1940 that Mr. Helm, under the direction of Dr. Christensen, became actively engaged in photofluorographic camera development.

We would like to bring this information to the attention of your readers so that the record on these fundamental developments may be clarified.

RUSSELL H. MORGAN, M.D.
DAVID M. GOULD, M.D.
WILLARD W. VANALLEN, B.Sc.

THE 1949 MEETING OF THE AMERICAN ROENTGEN RAY SOCIETY

Arrangements have been made to hold the Fiftieth Annual Meeting of the American Roentgen Ray Society in San Francisco, California. The dates of the meeting will be September 6, 7, 8 and 9, 1949.

PRELIMINARY PROGRAM

FORTY-NINTH ANNUAL MEETING OF THE AMERICAN ROENTGEN RAY SOCIETY

The Forty-ninth Annual Meeting of the American Roentgen Ray Society will be held at the Palmer House, Chicago, Illinois, on September 14, 15, 16, and 17 1948.

The Executive Council will meet at noon on Sunday, September 12.

The annual Golf Tournament for the Willis F. Manges Trophy will he held on Monday, September 13, at the Bunker Hill Golf Club, Niles, Illinois.

The Caldwell Lecture will be given on Wednesday evening, September 15, and the Annual Banquet will be held on Thursday evening, September 16.

The Instruction Courses will begin at 8:30 A.M. each day of the meeting, and elsewhere in this issue will be found the detailed plan of the courses.

The Scientific program has been tentatively arranged as follows:

Tuesday, September 14, 1948

8:30 A.M. Instruction Courses.

9:30 A.M. Study of Scientific and Technical Exhibits.

10:30 A.M. Call to Order, Forty-ninth Annual Meeting, J. Bennett Edwards, M.D., President.

Installation of the President-Elect, Lawrence Reynolds, M.D., Detroit, Michigan, by President Edwards and the Chairman of the Executive Council, Vincent W. Archer, M.D., Charlottesville, Va.

Inaugural Address: President Lawrence Reynolds, M.D.

11:30 A.M.

Paper No.

1. Round Table Discussion. Bronchogenic Carcinoma. William M. Tuttle, M.D., Detroit, Michigan, John R. McDonald, M.D., Rochester, Minnesota, William E. Adams, M.D., Chicago, Illinois (all by invitation), Eldwin R. Witwer, M.D., Detroit, Michigan, and Leo G. Rigler, M.D., Minneapolis, Minnesota.

2:00 P.M.

2. Symposium on the Diagnostic, Roentgenographic and Surgical Aspects of Congenital Heart Disease.

The Diagnosis of Congenital Pulmonary Stenosis and Other Important Congenital Cardiac Defects. Stanley Gibson, M.D., Chicago, Ill. (by invitation);

Venous Catheterization in Congenital Heart Disease. Lewis Dexter, M.D., Boston, Mass. (by invitation);

Roentgenographic Methods in the Diagnosis of Congenital Heart Disease other than by Angiocardiography. Edward B. D. Neuhauser, M.D., Boston, Mass. (by invitation);

Interpretation of Normal Cardiovascular Angiograms with a Discussion of Common Errors. Marcy L. Sussman, M.D., New York, N.Y.;

Congenital Cardiovascular Defects which are Demonstrable by Angiocardiography. Robert N. Cooley, M.D., and Robert D. Sloan, M.D., Baltimore, Md. (both by invitation);

The Automatization of Roentgenographic Technique in Cardiovascular and Angiographic Examinations by the Tautograph. Wendell G. Scott, M.D., St. Louis, Mo.;

The Surgical Treatment of Congenital Pulmonic Stenosis. C. Rollins Hanlon, M.D. and Alfred Blalock, M.D., Baltimore, Md. (both by invitation).

Discussion by Merrill C. Sosman, M.D., Boston, Mass., and Willis J. Potts, M.D., Chicago, Ill. (by invitation).

4:30 P.M. Executive Business Session of the Society.

Wednesday, September 15, 1948

8:30 A.M. Instruction Courses.

10:30 A.M. Study of Scientific and Technical Exhibits.

11:00 A.M.

3. Symposium on Considerations in the Diagnosis and Treatment of Diseases of the Chest, Emphasizing the Value of Group Consultation. Julian Johnson,

M.D., Simon Leopold, M.D., Joseph Atkins, M.D., Julius Comroe, M.D. (all by invitation), Robert P. Barden, M.D., Philadelphia, Penna.

Moderator: Eugene P. Pendergrass, M.D., Philadelphia, Penna.

2:00 P.M.

4. Medical and Roentgenological Aspects of Mass Chest Surveys. A. C. Christie, M.D., Washington, D.C.

Discussion by W. Edward Chamberlain, M.D., Philadelphia, Penna.

5. Cryptococcosis (Torulosis) of Bones. Vincent P. Collins, M.D. (by invitation).

Discussion by Harry M. Weber, M.D., Rochester, Minn.

6. The Fate of Oil Particles in the Lung and Their Relationship to the Development of Bronchiogenic Carcinoma: A Roentgenological and Pathological Study. L. R. Sante, M.D., St. Louis, Mo.

Discussion by John R. McDonald, M.D., Rochester, Minn. (by invitation).

7. Hemosiderosis of the Lung due to Mitral Disease: A Report of Six Cases Simulating Pneumonoconiosis. Eugene P. Pendergrass, M.D., Edwin L. Lame, M.D. (by invitation), and Herman W. Ostrum, M.D. (by invitation), Philadelphia, Penna.

Discussion by George LeRoy, M.D., Chicago, Ill. (by invitation).

8. The Role of Nitrogen Mustard as an Adjunct to Roentgen Therapy of Malignant Diseases. Bernard Roswit, M.D., Bronx, N.Y. (by invitation).

Discussion by Traian Leucutia, M.D., Detroit, Mich.

3:30 P.M.

9. Symposium on The Intensification of the Roentgenoscopic Screen.

Present Day Roentgenoscopes and Their Deficiencies. W. Edward Chamberlain, M.D., Philadelphia, Penna.

Fundamental Limitations of Screen Intensifying Systems. Ralph E. Sturm, M.D., Baltimore, M.D. (by invitation).

A New Image Tube for Brightening the Roentgenoscopic Screen. John W. Coltman, Ph.D., East Pittsburgh, Penna. (by invitation).

Clinical Potentialities of Screen Intensification. Russell H. Morgan, M.D., and John F. Roach, M.D. (by invitation), Baltimore, Md.

Discussion by Paul C. Hodges, M.D., Chicago, Ill., Robert J. Moon, Ph.D., Chicago, Ill. (by invitation), and Fred J. Hodges, M.D., Ann Arbor, Michigan.

Wednesday Evening, September 15, 1948

Eight-Thirty O'Clock

The Caldwell Lecture

B. R. Kirklin, M.D.

Chief of the Section of Roentgenology, Mayo Clinic;

Director of the Division of Radiology and Professor of Radiology,

Mayo Foundation Graduate School University of Minnesota, Rochester, Minnesota

"Graduate Education in Roentgenology"

Introduction—Lyell C. Kinney, M.D., San Diego, California

Thursday, September 16, 1948

8:30 A.M. Instruction Courses.

9:30 A.M. Study of Scientific and Technical Exhibits.

10:30 A.M.

10. Symposium on Radiobiology.

Findings on Total Body Radiation from Nuclear Sources. Shields Warren, M.D., Washington, D.C. (by invitation).

Recent Developments in the Study of Radiation Effects on the Hematopoietic System. Leon O. Jacobson, M.D., Chicago, Ill. (by invitation).

The Effect of Ionizing Radiations on Enzymes and Proteins. E. S. Guzman Barron, M.D., Chicago, Ill. (by invitation).

Radiobiological Additivity of Various Ionizing Radiations. Raymond E. Zirkle, Ph.D., Chicago, Ill.

Some Biologicl Effects of Long Continued Irradiation. Egon Lorenz, Ph.D., Bethesda, Md. (by invitation).

2:00 P.M.

10. Symposium on Radiobiology (concluded).

The Metabolic Properties of the Fission Products and Actinide Elements. Joseph G. Hamilton, M.D., Berkeley, Calif. (by invitation).

One unnanounced paper.

The Influence of Radiation Exposure on Length of Life of Laboratory Animals. Robert D. Boche, Ph.D., Chicago, Ill. (by invitation).

Discussion by Edith H. Quimby, M.A., Sc.D., New York, N.Y., and Paul Aebersold, Ph.D., Oak Ridge, Tenn. (by invitation).

3:00 P.M.

11. Dosimetry of Ionizing Particle, G. Failla, D.Sc., and H. H. Rossi, Ph.D. (by invitation), New York, N.Y.

12. Problem of Dosage Measurements for Radiations Above 1 Mev. Lauriston Sale Taylor, Ph.D., Washington, D.C.

13. Techniques for Application of the Betatron to Therapy. Donald W. Kerst, Ph.D., Henry Quastler, M.D., G. M. Almy, Ph.D., and the Betatron Staff, Physics Department, University of Illinois, Urbana, Ill. (all by invitation).

Discussion of above three papers by Kenneth E. Corrigan, Ph.D., Detroit, Mich.

14. Malignant Degeneration of Benign Giant Cell Tumor of Bone. Traian Leucutia, M.D., and James C. Cook, M.D. (by invitation), Detroit, Mich.

Discussion by F. A. Chandler, M.D., Chicago, Ill. (by invitation).

15. Cancer of the Lip. Bernard P. Widmann, M.D., Philadelphia, Penna.

Discussion by Edward L. Jenkinson, M.D., Chicago, Ill.

4:30 P.M. Executive Business Session of the Society.

Thursday Evening, September 16, 1948

Seven-Thirty O'Clock
Annual Banquet

Friday, September 17, 1948

8:30 A.M. Instruction Courses.

10:30 A.M. Study of Scientific and Technical Exhibits.

11 00 A.M.

16. Relative Incidence of Bone Lesions, Including Fractures. Sherwood Moore, M.D., Saint Louis, Mo.

17. The Roentgen Examination of the Cervical Spine. Joseph C. Bell, M.D., Louisville, Ky.

Discussion of above two papers by Maurice M. Pomeranz, M.D., New York, N.Y.

18. The Relation of Therapeutic Radiology to Clinical Medicine. A. U. Desjardins, M.D., Rochester, Minn.

Discussion by James T. Case, M.D., Chicago, Ill.

19. Intravenous Urography in the Study of Vesical Neck Obstruction. W. J. Engel, M.D., Cleveland, Ohio. (by invitation).

20. Deformities of the Bladder Secondary to Ureteral Stone. Harold O. Peterson, M.D., and Barnard Hall, M.D., Saint Paul, Minn. (both by invitation).

Discussion of above two papers by Vincent J. O'Conor, M.D., Chicago, Ill. (by invitation).

21. The Early Diagnosis of Gastric Cancer by Photofluorography. John F. Roach, M.D., Robert D. Sloan, M.D. (both by invitation), and Russell H. Morgan, M.D., Baltimore, Md.

Discussion by Sherwood Moore, M.D., *Saint Louis, Mo.*

2:00 P.M.

22. The Occurrence of Gastric Ulcer in Diaphragmatic Hernia. Glenn F. Miller, M.D. (by invitation), and Howard P. Doub, M.D., Detroit, Mich.

23. Gastrointestinal Food Hypersensitivity as Shown by the Roentgen Ray. E. J. Tallant, M.D., Frederick Urbach, M.D., and Hugh A. O'Neill, M.D., Philadelphia, Penna. (all by invitation).

24. A Rapid Method of Roentgenologic Examination of the Small Intestine. Sydney Weintraub, M.D., and Robert G. Williams, M.D., New York, N.Y. (both by invitation).

Discussion of above three papers by Ross Golden, M.D., New York, N.Y.

25. Subacute (Pseudotuberculous) Thyroiditis and Its Treatment. John D. Osmond, Jr., M.D. (by invitation), and U. V. Portmann, M.D., Cleveland, Ohio.

Discussion by Hugh F. Hare, M.D., Boston, Mass.

26. Some Partial and Complete Obstructions of the Respiratory Tract in the Newborn due to Tracheobronchial

Malformations. W. A. Evans, M.D., Detroit, Mich.

Discussion by Vincent W. Archer, M.D., Charlottesville, Va.

27. The Time Factor in Cerebral Angiography and the Automatic Seriograph. J. M. Sanchez-Perez, M.D. (by invitation), and R. A. Carter, M.D., Los Angeles, Calif.

Discussion by John F. Holt, M.D., Ann Arbor, Mich. (by invitation).

28. Placental Visualization by "Soft Tissue" Roentgenography. Paul A. Bishop, M.D., Philadelphia, Penna.

Discussion by E. Walter Hall, M.D., Detroit, Mich.

29. The Angiocardiographic Diagnosis of Syphilitic Aortitis. Israel Steinberg, M.D., Charles Dotter, M.D., George Peabody, M.D., George Reader, M.D., L. Heimhoff, M.D., and Bruce Webster, M.D., New York, N.Y. (all by invitation).

Discussion by March L. Sussman, M.D., New York, N.Y.

AMERICAN ROENTGEN RAY SOCIETY

SECTION ON INSTRUCTION

HARRY M. WEBER, M.D., *Director*

Titles and Abstracts of Courses Offered

Forty-Ninth Annual Meeting

Palmer House, Chicago, Illinois

September 14–17, 1948

President-Elect Reynolds, with the approval of the Executive Council, has directed that the Section on Instruction be continued for the 1948 annual meeting. He has arranged his program so that the Instruction Courses will be given between the hours of 8:30 A.M. and 9:30 A.M. on Tuesday and Thursday, and 8:30 A.M. and 10:30 A.M. on Wednesday and Friday. No other official activity will be scheduled during these hours, which will permit everyone at the meeting to attend the Instruction Courses each morning.

The Section on Instruction presents for 1948:

1. The Symposium on Radioactive Isotopes (Courses 101 to 105), with a faculty of five instructors, and covering five periods.

2. Two Special Courses, one on The Preparation and Presentation of Medical Papers (S-1), and one on Practical Roentgenography (S-2), with a faculty of two instructors, and covering five periods.

3. Six special Sequential Courses on Diagnostic Roentgenology (Courses "A" to "F") with a faculty of seven instructors, and covering thirteen periods.

4. Six single-period courses (201–206) on Radiation Physics, with a faculty of five instructors, and covering six periods.

5. Eleven single-period courses (301 to 311) on Therapeutic Radiology, with a faculty of eleven instructors, and covering eleven periods.

6. Twenty-one single-period courses (401 to 420) on Diagnostic Roentgenology, with a faculty of nineteen instructors, and covering twenty-one periods.

GENERAL INFORMATION

The Faculty

Louie T. Austin, D.D.S., Associate Professor of Dental Surgery, Mayo Foundation, University of Minnesota; Dental Surgeon and Head of Section on Dental Surgery, Mayo Clinic, Rochester, Minnesota.

Carl B. Braestrup, Senior Physicist, Department of Hospitals, New York City; Associate Professor of Radiology, New York University and Columbia University, New York, New York.

Ralph S. Bromer, M.D., Radiologist, Children's Hospital, Philadelphia, Pennsylvania, and The Bryn Mawr Hospital, Bryn Mawr, Pennsylvania; Clinical Professor of Radiology, Graduate School of Medicine, University of Pennsylvania, Philadelphia, Pa.

Arthur E. Childe, M.D., Radiologist, Children's Hospital of Winnipeg; Associate Radiologist, Winnipeg General Hospital, Winnipeg, Manitoba, Canada.

K. E. Corrigan, Ph.D., Director, Research Division, Harper Hospital, Detroit, Michigan.

Lilian Donaldson, M.D., Assistant Professor of Roentgenology, University of Chicago, Chicago, Illinois.

Howard P. Doub, M.D., Roentgenologist, Henry Ford Hospital, Detroit, Michigan.

Theodore P. Eberhard, Assistant Professor of Radiology, Jefferson Medical College and Hospital, Philadelphia, Pennsylvania.

Edwin C. Ernst, M.D., Director, Radiological Department, Barnard Free Skin and Cancer Hospital, Saint Louis, Missouri.

Robert E. Fricke, M.D., F.A.C.R., Associate Professor of Radiology, Mayo Foundation, University of Minnesota; Consultant on Radium Therapy, Mayo Clinic, Rochester, Minnesota.

Arthur W. Fuchs, Medical Division, Eastman Kodak Company, Rochester, New York.

Ross Golden, M.D., Professor of Radiology, College of Physicians and Surgeons, Columbia University; Director of the Radiological Service, Presbyterian Hospital, New York, New York.

C. Allen Good, M.D., M.S. in Radiology. Assistant Professor of Radiology, Mayo Foundation, University of Minnesota; Radiologist, Mayo Clinic, Rochester, Minnesota.

Joseph G. Hamilton, B.S., M.D., Professor of Medical Physics, University of California, Los Angeles, California.

H. F. Hare, M.D., Radiologist, Lahey Clinic, Boston, Massachusetts.

Richard M. Hewitt, M.A., M.D., Assistant Professor of Medical Literature, Mayo Foundation, University of Minnesota; Editor and Head of Division of Publications, Mayo Clinic, Rochester, Minnesota.

Fred Jenner Hodges, M.D., Professor of Roentgenology, University of Michigan, Ann Arbor, Michigan.

John F. Holt, M.D., Associate Professor of Roentgenology, University of Michigan, Ann Arbor, Michigan.

Harold W. Jacox, M.D., Professor of Radiology, College of Physicians and Surgeons, Columbia University; Chief of Radiotherapy Division of Radiological Service, Presbyterian Hospital, New York, New York.

B. R. Kirklin, M.D., F.A.C.P., F.A.C.R., Professor of Radiology, Mayo Foundation, University of Minnesota; Radiologist and Head of Section on Radiology, Mayo Clinic, Rochester, Minnesota.

Isadore Lampe, M.D., Associate Professor of Roentgenology, University of Michigan, Ann Arbor, Michigan.

Eugene T. Leddy, M.D., F.A.C.R., Associate Professor of Radiology, Mayo Foundation, University of Minnesota; Consultant on Roentgen Therapy, Mayo Clinic, Rochester, Minnesota.

Maurice Lenz, M.D., Professor of Clinical Radiology, Columbia University, New York; Consultant Radiotherapist to the Manhattan Eye, Ear and Throat Hospital, Montefiore Hospital and Presbyterian Hospital, New York, New York.

Traian Leucutia, M.D., Director, Department of Radiotherapy and Associate Radiologist, Harper Hospital, Detroit, Michigan.

A. S. Macmillan, M.D., Radiologist, Massachusetts Eye and Ear Infirmary, Boston, Massachusetts.

Charles L. Martin, M.D., Professor of Radiology, Southwestern Medical College, Dallas, Texas.

Edward B. D. Neuhauser, M.D., Radiologist, Infants' and Children's Hospitals; Associate in Radiology, Harvard Medical School, Boston, Massachusetts.

W. J. Oosterkamp, M.D., Research Laboratory of N. V. Philips Gloilampenfabrieken, Eindhoven, Holland.

Lester W. Paul, M.D., Professor of Radiology, University of Wisconsin, Madison, Wisconsin.

Carleton B. Peirce, A.B., M.Sc., M.D., F.A.C.P., Radiologist-in-Chief, Royal Victoria Hospital; Chairman, Department of Radiology, Faculty of Medicine, McGill University, Montreal, Quebec, Canada.

Harold O. Peterson, M.D., Clinical Associate Professor of Radiology, University of Minnesota, Minneapolis, Minnesota; Radiologist to Miller Hospital and Children's Hospital, Saint Paul, Minnesota.

U. V. Portmann, M.D., Director of Therapeutic Radiology, Cleveland Clinic Foundation, Cleveland, Ohio.

Edith H. Quimby, Sc.D., Associate Professor of Radiology (Physics), College of Physicians and Surgeons, Columbia University, New York, New York.

W. S. Randall, A.B., M.D., Department of Pathology, Ochsner Clinic and Tulane University; Pathologist, Foundation Hospital, New Orleans, Louisiana.

Edward H. Reinhard, M.D., Assistant Professor of Medicine and Assistant Professor of Radiology, Washington University School of Medicine, Saint Louis, Missouri.

Leo G. Rigler, M.D., Professor of Radiology, University of Minnesota, Minneapolis, Minnesota.

L. R. Sante, M.D., Professor of Radiology and Director of Department, Saint Louis University School of Medicine, Saint Louis, Missouri.

Richard Schatzki, M.D., Mount Auburn Hospital, Cambridge, Massachusetts.

Wendell G. Scott, M.D., Associate Professor of Clinical Radiology, Washington University School of Medicine; Associate Director, Mallinckrodt Institute of Radiology, Saint Louis, Missouri.

William Snow, M.D., Roentgenologist-in-Charge, Harlem Hospital; Director of Radiology, Bronx Hospital, New York, New York.

Paul C. Swenson, M.D., Professor of Radiology, Jefferson Medical College, Philadelphia, Pennsylvania.

Robert B. Taft, M.D., B.S., M.A., Professor of Radiology, Medical College of State of South Carolina, Charleston, South Carolina.

Lauriston S. Taylor, A.B., Chief, X-ray Section, National Bureau of Standards, Washington, D. C.

J. L. Weatherwax, M.A., Physicist, American Oncologic Hospital, Assistant Professor of Radiotherapeutic Physics, Graduate School of Medicine, University of Pennsylvania. Philadelphia, Pennsylvania.

Bernard P. Widmann, M.D., Chief Radiologist, Philadelphia General Hospital; Chairman of the Graduate School in Radiology, University of Pennsylvania, Philadelphia, Pennsylvania.

Marvin M. D. Williams, M.S., Ph.D., Associate Professor of Biophysics, Mayo Foundation, University of Minnesota; Biophysicist, Mayo Clinic, Rochester, Minnesota.

George M. Wyatt, M.D., The Radiological Clinic of Doctors Groover, Christie and Merritt, Washington, D. C.

Barton R. Young, M.D., Professor of Radiology Temple University, Philadelphia, Pennsylvania.

Conference Periods

Tuesday, Wednesday, Thursday and Friday mornings

First period.....8:30– 9:20 A.M.
Second period.....9:30–10:30 A.M.

Location

All courses will be given in rooms 705, 706, 731, 732, 733, 734, 736, 738, 740, 744, located on the seventh floor of the Palmer House. Full information may be obtained at the general registration desk which will be located on the Fourth Floor.

Code

The periods of instruction will be designated with code letters and numbers as follows:

T-1 Tuesday, single period.....8:30– 9:30 A.M.
W-1 Wednesday, first period.....8:30– 9:20 A.M.
W-2 Wednesday, second period...9:30–10:30 A.M.
Th-1 Thursday, single period.....8:30– 9:30 A.M.
F-1 Friday, first period.....8:30– 9:20 A.M.
F-2 Friday, second period.....9:30–10:30 A.M.

(Familiarity with this code will help to avoid confusion)

How to Register and Obtain Tickets for the Instruction Courses

Admission to the Instruction Courses will be by ticket only.

Following the list of titles and abstracts there is a general order sheet. First, second and third choices for each period should be selected carefully and indicated on the order. The rooms in which the courses will be given are not large, which places a limitation on the number of persons who will be able to attend individual courses. It is estimated that the number who can attend will range between thirty-five and fifty. If the directions given on the order sheet are followed explicitly, errors in completing reservations will be minimized.

Persons requesting registration in one or more of the Sequential (continuous) Courses (S-2, A, B, C, D, E, F) should indicate second and third choices of single-period courses as substitutes for each period—this is to avoid disappointment should the Sequential Courses be filled when the order is received.

It is possible for one to attend only six periods of instruction, so the condensed schedule given on the last pages of this program should be consulted with care when registering and ordering tickets.

Reservations will be made in the order in which the order forms are received. Those who are not members of the American Roentgen Ray Society will be charged the nominal fee of $1.00 per period of instruction, or a maximal fee of $5.00 for five or more periods. Full-time graduate students in Radiology will be admitted without fee.

Previous to September 4, 1948, the order forms should be sent to the Director, Dr. Harry M Weber, Rochester, Minnesota. After September 4, the orders should be

sent directly to Dr. Harry M. Weber, Palmer House, Chicago, Illinois.

In case the courses are not filled by the time of the meeting, tickets will be available at the registration desk on Sunday, September 12, and thereafter during the meeting.

Holders of Tickets

Those who do not have the proper ticket for the assigned course will not be permitted to enter the room. Pages will be in attendance in each conference room to collect tickets.

DESCRIPTION OF COURSES

I. The Symposium on Radioactive Isotopes

COURSE 101

Room 705 Period: T-1

M. M. D. WILLIAMS, Ph.D.,
Rochester, Minn.

The Nature and Production of Radioisotopes

The difference between stable and radioactive isotopes and the methods of producing them will be discussed briefly. Most of the discussion will be on the physical characteristics of radioisotopes: rates of decay, half-life, types of radiation emitted and the properties of the radiations. Those characteristics of importance to a radiologist who may use radioisotopes will be stressed. Some of the more important problems relating to the protection of personnel working with radioisotopes will be mentioned.

COURSE 102

Room 705 Period: W-1

EDITH H. QUIMBY, Sc.D.,
New York, N. Y.

Dosage Problems in the use of Radioactive Isotopes

Discussion of physical characteristics (activity, half-life, type and energy of radiation).

Tissue dosage determinations, when introduced into the body as chemical compounds. Influence of rate of decay, elimination, local concentration. Dangers in the use of radioactive isotopes internally administered. Protection of personnel. Dosage data and charts will be presented.

COURSE 103

Room 705 Period: Th-1

JOSEPH G. HAMILTON, M.D.,
Berkeley, Calif.

The Clinical Applications of Radioactive Iodine

Radioactive iodine has been employed as a therapeutic agent for the treatment of Graves' disease for a number of years. The initial clinical trials of this agent were made in 1941. Since then an ever-increasing number of patients with hyperthyroidism have been treated with radio-iodine. At the present time more than a dozen large medical centers are pursuing active programs using radio-iodine for this purpose. Coincidentally, considerable effort has been directed toward evaluating the potential use of radio-iodine in the treatment of malignant disease of the thyroid. Here the picture has been rather discouraging when compared to the relatively successful results obtained with radio-iodine therapy for hyperthyroidism. A review will be presented of the status of radio-iodine in the treatment of these two thyroid disorders.

COURSE 104

Room 705 Period- F-1

K. E. CORRIGAN, Ph.D.,
Detroit, Mich.

The Practical Use of Tracer Isotopes

The classes of tracer isotopes applicable to medical problems will be presented and their specific applications discussed in some detail. The considerations which control the choice of the proper isotope for a particular problem and the results to be expected will be presented.

II. SEQUENTIAL COURSES

COURSE A

(2 periods)

Room 736 Periods: Th-1; F-1

RALPH S. BROMER. M.D.,
Philadelphia, Pa.

The Differential Diagnosis of Skeletal Changes Occurring in Diseases of Infants and Children

The time allotted will be spent in discussing the differential roentgen diagnosis of skeletal changes occurring in diseases of infancy and childhood. All such diseases cannot be included in the time available for the course. Case material will be chosen from the following list: congenital syphilis, rickets, in-

fantile scurvy, tuberculosis, lead poisoning, the blood dyscrasias, xanthomatosis and allied conditions, osteogenesis imperfecta, achondroplasia, multiple enchondromata, multiple cartilaginous exostoses, metastases caused by neuroblastoma, osteochrondritis and endocrine disturbances. Wherever possible the early roentgen changes will be emphasized. The question of differential diagnosis will be approached from the standpoint of the predisposition of the various diseases to affect certain bones or certain areas of individual bones. Thus in the case of the long bones, differential roentgen signs of the disease processes in the epiphysis, the diaphysis, the metaphysis, the periosteum, cortex, etc., will be given in detail.

COURSE 105

Room 705 Period: F-2

EDWARD H. REINHARD, M.D.,
St. Louis, Mo.

The Treatment of Blood Dyscrasias and Malignant Lymphomas with Radioactive Phosphorus, Radioactive Sodium, and Colloidal Preparations of Various Radioactive Isotopes

Approximately 300 patients with polycythemia vera, various types of leukemia, and malignant lymphomas have been treated with radioactive phosphorus at the Mallinckrodt Institute of Radiology in St. Louis. The method of treatment and the clinical results in these patients will be discussed. Complete hematologic and almost complete symptomatic remissions can be produced with P^{32} in the vast majority of patients with polycythemia vera, and remission from a single course of treatment may last for some six months to three or four years or even longer. Radioactive phosphorus has been found to be of no value in the treatment of acute or subacute leukemia, but patients with chronic myelogenous and chronic lymphatic leukemia can be controlled very satisfactorily by this form of treatment. The theoretical advantages of radioactive phosphorus over roentgen rays are: (1) the radioactive material is taken up collectively by the bone marrow and, to a certain extent, the lymph nodes and spleen; (2) with radioactive phosphorus, the radiation to which the patient is exposed is of low intensity but prolonged over a considerable period of weeks. The theoretical advantages of this will be discussed; (3) radiation sickness is unknown with P^{32}.

Isotopes of sodium have been tried in the treatment of leukemia in other laboratories. Na^{24}, which is the isotope that has been commonly employed, has a half-life of 14.8 hours and emits both beta rays and gamma rays. This element is distributed evenly to the tissue fluids throughout the body and there is no selective uptake by bone marrow or lymphatic tissue. However, chronic leukemia will respond favorably to radioactive sodium therapy just as it responds to general body roentgen irradiation. Radioactive sodium is easy to prepare and is inexpensive.

Colloidal suspensions of various radioactive isotopes have been administered intravenously to experimental animals and the distribution of the material studied. It has been found that the colloidal particles are taken up selectively by the reticuloendothelial cells of the body. The highest concentrations are found in the liver, spleen, and bone marrow. These studies suggested the possibility of using some such preparation in the treatment of Hodgkin's disease, reticulum cell sarcoma, and other tumors arising in the reticuloendothelial system. Colloidal suspensions of radioactive chromic phosphate, radioactive iron phosphate, radioactive manganese, and radioactive gold have been employed in various laboratories in the treatment of the malignant lymphomas. In some instances encouraging results have been obtained.

COURSE B

(3 periods)

Room 738 Periods: W-1; Th-1; F-1

ROSS GOLDEN, M.D.,
New York, N. Y.

Roentgenology of the Small Intestine

Tuesday

- Technique
- Normal small intestine
 - Anatomy
 - Physiology
- Indications for small intestine study
- Diverticula
- Disturbances in physiology
 - Emotion
 - Vagotonia
 - Multiple peritoneal adhesions
- Developmental anomalies
 - Internal hernia
 - Congenital diaphragm
- Effect of disease of the mesentery
 - Localized
 - Generalized
 - Lymphoblastoma
 - Sclerosing mesenteritis

Wednesday

- The "Deficiency Pattern"
 - Vitamin deficiency states
 - Hypoproteinemia
 - Biliary tract disease
 - Pancreatic disease
- Allergy
- Inflammations
 - Tuberculous
 - Non-tuberculous
 - Sclerosing regional enteritis
 - Non-sclerosing regional enteritis

Thursday

Neoplasms
- Benign
- Malignant
 - Carcinoma and carcinoid
- Lymphosarcoma
 - Localized
 - Diffuse

Benign ulcer

Ileus
- Diagnosis by 3 position abdominal films
 - Paralytic
 - Mechanical
 - Mesenteric vascular occlusion
- The Miller-Abbott tube
 - Technique of insertion
 - Deflation
 - Injection of barium for
 1. Localization
 2. Demonstration of type of obstruction
- Complications

COURSE C

(2 periods)

Room 706 Periods: Th-1; F-1

CARLETON B. PEIRCE, M.D.,
Montreal, Quebec

Bronchography

The first period will be devoted to the gross and roentgen anatomy of the thoracic viscera, the bronchovascular pattern, the distribution of the branches of the bronchial tree with special relation to the segments of the lungs and nomenclature.

The second period will include consideration of the various techniques for bronchographic examination and the interpretation of the resulting bronchograms.

COURSE D

(2 periods)

Room 731 Periods: W-1; W-2

LEO G. RIGLER, M.D.,
Minneapolis, Minn.

Roentgen Manifestations of Bronchogenic Tumors

The roentgen findings obtained with various types of bronchogenic tumors will be discussed with particular reference to the following:

1. The possibilities and limitations of roentgen diagnosis of bronchogenic tumors.
2. The roentgen delineation of the tumor mass.
3. Inflammatory changes associated with bronchogenic tumors.
4. The roentgen evidences of bronchial obstruction such as emphysema, atelectasis, and secondary inflammatory changes.
5. The demonstration of the bronchial tumor by bronchography and planigraphy.
6. The special findings in bronchial adenoma.

Diagrams and reproductions of roentgenograms will be demonstrated to illustrate these various findings.

COURSE E

(2 periods)

Room 733 Periods: W-1; W-2

WILLIAM SNOW, M.D.,
New York, N. Y.

Roentgen Study of Pregnancy

Part 1 (W-1): The technique of roentgenography.

Part 2 (W-2): A simplified method of analyzing the roentgenograms. Measurements. The architecture of the female pelvis. Demonstration will be made with lantern slides and with original roentgenograms.

COURSE F

(2 periods)

Room 731 Periods: Th-1; F-1

GEORGE M. WYATT, M.D.,
Washington, D.C., and
W. S. RANDALL, M.D.,
New Orleans, La.

Benign and Malignant Lesions of Bone

This material is largely selected from the cases admitted to the Walter Reed General Hospital in its capacity as a tumor center during World War II. Lantern slides include the roentgenographic, gross, and microscopic appearance of the various lesions.

Among the conditions to be considered are osteomyelitis, osteoid osteoma, fibrous dysplasia, eosinophilic granuloma, giant cell tumor, lymphoma, chondrosarcoma, osteogenic sarcoma, Ewing's tumor, neuroblastoma, and myeloma.

Attention will be directed to correlation of the roentgen appearance and gross pathology and to differential diagnosis of benign and malignant lesions. Therapeutic measures will also be discussed.

III. SPECIAL COURSES

COURSE S-1

Room 731 Period: T-1

RICHARD M. HEWITT, M.D.,
Rochester, Minn.

Suggestions Concerning the Writing and Presentation of Medical Papers

1. Form of the medical manuscript.
2. Devices which aid toward orderly arrangement.
2. Some typical erroneous expressions.
4. The tabular or textual stereoptican slide.

COURSE S-2

(4 periods)

Room 734 Periods: W-1; W-2; F-1; F-2

ARTHUR W. FUCHS,
Rochester, N. Y.

Influence of Exposure Factors on Roentgenographic Quality

The roentgenologist is not so much interested in the occasional excellent roentgenogram as he is in obtaining a consistently uniform series of good quality roentgenograms from day to day. The large number of roentgenograms that must be produced in the modern laboratory demands standardization of exposures so that a reasonable uniformity results. The course will demonstrate a practical approach to the use of exposure factors that affect density and contrast, hence, roentgenographic quality. The subject matter will be generously illustrated with roentgenograms demonstrating the points discussed.

IV. THERAPEUTIC RADIOLOGY

COURSE 301

Room 733 Period: Th-1

THEODORE P. EBERHARD, M.D.,
Philadelphia, Pa.

Treatment of Leukemias and Lymphomas

The radiologist must often act as his own hematologist and assume full control of these cases. The armamentarium now includes a large array of substances, such as urethane, aminopterin, methopterin, amfol R, brewer's yeast, nitrogen mustard gas and others. The particular place for each of these and its integration into the scheme of treatment along with roentgen therapy will be discussed.

COURSE 302

Room 706 Period: F-2

E. C. ERNST, M.D., St. Louis, Mo.

Practical Concepts of Radiation Treatment of Carcinoma of the Cervix Uteri

SYNOPSIS

(a) *Clinical Management and Preliminary Considerations*
(b) *Indications for Roentgen Therapy:*
 1. Indirect irradiation of the pelvis.
 2. Direct (intravaginal) roentgen-ray applications.
(c) *Essential Tumor Dose Measurement Factors*
(d) *Indications for Radium Therapy:*
 1. Evaluation of the various methods and the intracervical applicators.
 2. Essential minimum requirements for obtaining the ideal uniform distribution of radium radiations.
(e) *Prognostic Factors:*
 1. Tumor grading.
 2. Stage of the disease.
 3. Initial response to preliminary roentgen irradiation.
(f) *Final Discussion Period:*
 Case presentations.
 2. Questions (15 minutes).

ABSTRACT

The practical irradiation management of carcinoma of the cervix will be discussed both from the standpoint of the institutional tumor clinic and the private office procedure. Although realizing that the radiation treatment standards continue to remain somewhat in a state of flux and that individualization in the application of roentgen rays and radium is a most essential consideration, nevertheless certain fundamental concepts in our routine procedures are most helpful in the management of cancer of the cervix. These and many other practical therapeutic considerations, including external roentgen therapy, intracavity radium and roentgen methods of treatment and the dosage measurement problems, will be discussed and illustrated.

COURSE 303

Room 740 Periods: F-1

R. E. FRICKE, M.D., Rochester, Minn.

Radium Therapy for the Less Common Malignant and Non-Malignant Conditions

Much has been written and taught regarding radium therapy for the more usually encountered malignant and inflammatory conditions known to respond to irradiation. However, the radiologist is often confronted with rare lesions which also are sensitive to irradiation. Lesions such as carcinoma of

the penis, Peyronie's disease, cancer of the urethra, chronic lymphedema of the face, cystic hygroma, and other rare diseases, merit discussion. General principles of treatment and technique will be emphasized.

COURSE 304

Room 733 Period: F-1

ISADORE LAMPE M.D.,
Ann Arbor, Mich.

Radiation Therapy of Selected Miscellaneous Non-Malignant Conditions

At the University Hospital of the University of Michigan, the practice of the Section on Radiation Therapy includes the treatment of a large heterogeneous group of diseases which are not neoplastic, Of these a number have been selected for discussion of clinical and therapeutic aspects:

Simple inflammations and infections
Acute parotitis
Acute postpartum mastitis
Tuberculous lymphadenitis
"Thymus"
Spondylitis rhizomelique
Myasthenia gravis

COURSE 307

Room 744 Period: F-2

T. LEUCUTIA, M.D., Detroit, Mich.

Comparison of 200 kv. and Supervoltage Roentgen Therapy

I. *Physical Aspect.* Supervoltage roentgen therapy differs from the 200 kv. therapy at least on three points:

1. There is an increase in the differential action of the roentgen rays with increasing voltages, whether this action be a direct or indirect function of the quality of the roentgen rays.
2. An increasingly larger physical dose of radiation can be administered with increasing voltages to produce a similar biologic effect, especially skin erythema.
3. The percentage depth dose, in addition to certain other deviations, shows an appreciable increase with higher voltages.

II. *Clinical Aspect.* In estimating the clinical value, one may distinguish between the immediate effect and late results:

1. The immediate effect is superior with supervoltage roentgen therapy in a well selected group of malignant neoplasms: (*a*) due to the fact that because of the above physical factors, the radiation is more homogeneous and efficacious, and (*b*) since a larger total dose can be administered with a lesser damage to the skin.
2. The late results are dependent on a good immediate effect and on a relatively low malignancy index of the irradiated neoplasm, so that the tumor remains local. Five-year statistical data are given.

COURSE 305

Room 733 Period: T-1

EUGENE T. LEDDY, M.D.,
Rochester, Minn.

Roentgen Therapy for Carcinoma of the Breast

The theoretical, technical and statistical aspects of the preoperative use of roentgen therapy in cases of carcinoma of the breast will be reviewed briefly. The reasons why this type of therapy is not used at the Mayo Clinic will be presented. For several years, a fairly constant postoperative roentgen technique has been used; its clinical efficacy will be considered in detail.

COURSE 306

Room 706 Period: T-1

MAURICE LENZ, M.D.,
New York, N. Y.

Radiotherapy of Ocular Lesions

Radium and roentgen therapy of inflammatory lesions and neoplasms in and about the eye are influenced by the radiosensitivity of the conjunctiva, cornea and lens, and the radioresistance of the retina. In lesions limited to the lid, the globe may be excluded by lead shields. Radiotherapy of various inflammatory and neoplastic diseases of the eye will be discussed in detail.

COURSE 308

Room 706 Period: W-2

CHARLES L. MARTIN, M.D.,
Dallas, Texas

Complete Care of Cancer of Mouth and Lip Including Cervical Metastases with Irradiation Alone

A plan for the complete radiological care of all stages of cancer of the mouth and lip will be described. Although both radium and roentgen rays are used, the equipment is relatively inexpensive and the time of treatment is short. Much emphasis will be placed on the intensive irradiation of metastatic cervical glands, using a combined roentgen-ray and interstitial radium technique, which has yielded some very promising results. Detailed descriptions of the procedure used in a number of actual cases have been prepared for presentation.

COURSE 309

Room 733 Period: F-2

U. V. PORTMANN, M.D.,
Cleveland, Ohio

Contact Roentgen Therapy for Superficial Lesions

This will be a presentation with Kodachrome slides of cases of epitheliomas, hemangiomas, verruca and similar conditions given contact roentgen therapy. Results will be shown and techniques used for treatment will be described. Some of the difficulties and contraindications of this method will be discussed.

COURSE 310

Room 705 Period: W-2

HAROLD W. JACOX, M.D.,
New York, N. Y.

Complications Following Irradiation of the Pelvis

The discussion will include those complications which are general and local, both immediate and late, of slight and serious consequence. Consideration will be given to details of the rate and methods of applying roentgen and radium therapy for pelvic lesions. The various organs involved will be evaluated from the standpoint of their tolerance to irradiation. The mechanism and management of these complications will be considered with a view to avoiding them if possible.

COURSE 311

Room 732 Period: Th-1

BERNARD P. WIDMANN, M.D.,
Philadelphia, Pa.

Radiation Therapy in Cancer of the Skin

Technical procedures for the radium and roentgen treatment of cancer of the skin will be reviewed and analyzed in detail. A definite predetermined plan of dosage has been formulated according to the estimated surface area and thickness of the lesion. Special emphasis will be placed on the value of low voltage roentgen rays (100–135 kv.), and a clinical comparison with radium will be made according to a great variety of patterns for single and multiple radium tubes with different sizes of fields, filters and distances. Conclusions will be drawn from a large clinical experience with massive and fractional doses. Determination of the "maximum safe dose," the "minimal effective dose," the daily intensity and the probable best rate of administration will be considered with specific recommendations after a routine experience demonstrating results and skin tolerance.

V. RADIATION PHYSICS

COURSE 201

Room 740 Period: T-1

CARL B. BRAESTRUP. Ph.D.,
New York, N. Y.

Common Causes of Radiation Hazards in Radiology

Radiation injuries are due mainly to improper operating procedures, faulty equipment, or inadequate structural shielding.

Operating Procedures: Fracture setting under fluoroscopy has been the cause of most radiation injuries in diagnostic roentgenology. The greatest hazards in therapy are the omission of the filter and incorrect use of ionization instruments.

Equipment: Improvements in roentgen-ray tube design has so increased the available dosage rate that permanent skin injuries may be produced in a few seconds. Roentgen therapy equipment should therefore be provided with accurate means for the control of the dose.

The protection afforded the patient and the fluoroscopist depends largely upon the construction of the fluoroscope. The use of long target-panel distances and adequate filtration reduces materially the exposure to the patient. The dose received by the operator is minimized by proper diaphragming of the useful beam and ample shielding against scattered radiation.

Structural Shielding: The use of protective equipment has often produced a false sense of security, especially if represented as "ray-proof." Obviously, barriers must be provided in any case against the useful beam and scattered radiation. Radiation injuries due to inadequate structural shielding seldom manifest themselves for years when permanent damage has already been done. No roentgen-ray installations, therefore, should be considered safe until so established by radiation measurements.

Radium Therapy: The hazards associated with typical radium and radon applications will be discussed.

COURSE 202

Room (to be announced) Period Th-1

W. J. OOSTERKAMP, M.D.,
Eindhoven, Holland

The Dosage Characteristics of Contact Roentgen Therapy Apparatus in Air and Water Phantoms

COURSE 203

Room 740 Period: Th-1

ROBERT B. TAFT, M.D.,
Charleston, S. C.

Dosage Measurement from a Clinical Standpoint

The various methods in common use for measuring clinical roentgen-ray dosage will be discussed, and the advantages and disadvantages of each pointed out. The value of the roentgen as a clinical unit will be compared with formerly used units. Pros and cons for the direct dosage measurement on the skin of the patient throughout the treatment time will be given. Air measurements versus skin measurements will be outlined and tables given for backscattering at commonly used wavelengths. Brief mention will be made of methods of determining stray radiation around a laboratory, either medical or industrial. Half of the period will be taken up with the above and round table discussion will follow. Throughout, an earnest effort will be made to keep the matter within the scope of the clinical radiologist who has little knowledge of, or interest in, pure physical measurements. The instructor, having had experience in both clinical and physical work, will attempt to narrow the far-too-wide gap between the clinician and physicist.

COURSE 204

Room 740 Period: W-1

LAURISTON S. TAYLOR, Ph.D.,
Washington, D. C.

High Voltage Generators

COURSE 205

Room 740 Period: W-2

J. L. WEATHERWAX, M.A.,
Philadelphia, Pa.

Factors Affecting Roentgen-Ray Dosage

Roentgen-Ray Dosage: The effect of radiation quality, focal skin distance, size of field, depth of underlying tissue in the treatment of skin and deep-seated lesions.

Application of iosodose charts and tables in determining tumor doses, emphasizing more complete treatment records.

COURSE 206

Room 740 Period: F-2

J. L. WEATHERWAX, M.A.,
Philadelphia, Pa.

Factors Affecting Radium Dosage

Basis for expressing radium dosage in gamma roentgens.

Arrangement of radium tubes and needles according to Paterson and Parker curves relating milligram-hours to various lengths and areas of radium applicators to deliver 1,000 gamma roentgens.

Application of Quimby's tables to radium tubes and needles in gamma roentgens.

VI. DIAGNOSTIC RADIOLOGY

COURSE 401

Room 734 Period: Th-1

LOUIE T. AUSTIN, D.D.S.,
Rochester, Minn.

Interpretation of the Dental Roentgenogram

The subject will be presented by means of lantern slides of selected dental roentgenograms showing dental abnormalities commonly encountered. The clinical significance of these will be stressed.

COURSE 402

Room 736 Period: T-1

ARTHUR E. CHILDE, M.D.,
Winnipeg, Manitoba

The Normal Encephalogram and Ventriculogram Congenital Abnormalities of the Brain

The roentgen technique of cerebral pneumography will be discussed and the importance of a few simple manipulations of the head during this procedure will be explained. This will be followed by a review of the normal anatomy of the ventricular system, basal cisterns and cortical markings. The pneumographic features of various congenital abnormalities will be shown.

COURSE 403

Room 736 Period: W-1

ARTHUR E. CHILDE, M.D.,
Winnipeg, Manitoba

The Pneumographic Diagnosis of Expanding, Contracting and Atrophic Intracranial Lesions

The deformities produced by various types of expanding intracranial lesions will be shown. Encephalography is often used to determine the cause of epileptic seizures in patients who do not suffer from brain tumors, and some examples of atrophic and contracting intracranial lesions will also be illustrated.

COURSE 404

Room 736 Period: W-2

LILIAN DONALDSON, M.D.,
Chicago, Ill.

The Early Diagnosis of Gastric Cancer

The topic will be discussed in detail illustrated with

actual roentgenograms projected by means of a mirror system. Common pitfalls of the diagnostic problem will be stressed and methods and interpretations available for avoiding them will be offered.

COURSE 405

Room 744 Period: T-1

HOWARD P. DOUB, M.D.,
Detroit, Mich.

Myelography

A general review of myelography will be presented covering the technique, the various steps in its evolution, and the different media which have been employed.

In connection with the application of the procedure to the diagnosis of protruded intervertebral disk, a brief review will be given of the development of the disk, its anatomy and physiology, and the changes incident to senescence. Some clinical aspects of disk protrusion will also be covered.

The diagnosis of tumors of the cord, of obstruction due to spinal tumors with pressure effects on the cord, and of inflammatory processes will also be considered.

COURSE 406

Room 732 Period: W-1

C. ALLEN GOOD, M.D.,
Rochester, Minn.

The Small Intestine

All of the lesions commonly encountered in the small intestine will be discussed. Special emphasis will be placed upon the diagnosis of the organic lesions which are amenable to surgical treatment, such as enteritis, Meckel's diverticulum and benign and malignant tumors.

Particular attention will be paid to the roentgenoscopic method of examination and there will be a brief consideration of the clinical indications for a roentgenologic examination of the small intestine.

Lantern slides of roentgenograms and of colored photographs of the pathologic material will be presented.

COURSE 407

Room 732 Period: F-2

HUGH F. HARE, M.D.,
Boston, Mass.

Recent Studies on Certain Intracranial Measurements

1. The measurement of the sella turcica in the normal child and adult by the lateral contour method and by the posteroanterior projection. A discussion of the various changes in the sella turcica produced by intrasellar and parasellar lesions.

2. A review of the methods of pineal measurement.

COURSE 408

Room 731 Period: F-2

FRED JENNER HODGES, M.D.,
Ann Arbor, Mich.

Intracranial Angiography

The indications for this type of examination will be outlined and the required technical procedures will be discussed. Examples of angiographic results in the examination of various patients typifying the major forms of intracranial abnormality which can be detected by this method will be presented.

Although this is very highly specialized form of roentgen diagnosis with a relatively narrow field of application, the degree of diagnostic accuracy which it brings to neurosurgical problems is not to be overlooked. Even though a radiologist does not employ it himself he should be fully aware of its potentialities.

COURSE 409

Room 734 Period: T-1

JOHN F. HOLT, M.D.,
Ann Arbor, Mich.

The Mechanisms of Skeletal Growth

The practicing radiologist, whose day to day activities are necessarily keyed to the clinical level, must on occasion refer to knowledge derived from the basic sciences in order to understand adequately alterations in roentgen appearance which must then be translated into terms of disease. This is particularly true in the case of growing bone, whether the alteration observed is a normal anatomic variation, of which there are many, or an obscure pathologic process which defies immediate classification. By the use of specific examples an attempt will be made in this course to show how a reasonable understanding of the fundamentals underlying osseous development will serve to facilitate roentgenologic interpretation in this particular field.

COURSE 410

Room 738 Period: F-2

B. R. KIRKLIN, M.D.,
Rochester, Minn.

Newer Developments in Cholecystography

The cholecystographic diagnosis of tumors of the gallbladder will be discussed in detail, also some newer developments in technique will be presented.

COURSE 411

Room 744 Period: W-1

A. S. MACMILLAN, M.D.,
Boston, Mass.

Roentgen Examination of the Sinuses

1. Roentgen examination of the sinuses is a very important part of the diagnosis of pathology in these locations. The rhinologist is dependent upon a correct interpretation of the sinus roentgenograms. The findings should be reported in terms of pathology, and not in the indefinite roentgenological terms so often used. In this presentation, the technique of examination and interpretation will be considered as fully as time will allow.

COURSE 412

Room 744 Period: Th-1

A. S. MACMILLAN, M.D.,
Boston, Mass.

Roentgen Examination of the Mastoids

2. The use of chemotherapy and antibiotics has greatly changed the course of infection in the mastoid. Pediatricians and general medical practitioners sometimes feel competent to treat this condition, but too often the treatment is inadequate. The roentgenologic examination of the mastoid is the only dependable source of information. This should be recognized, because mastoiditis is still prevalent. Acute and chronic infections of the mastoid and the complications will be discussed.

COURSE 413

Room 744 Period: F-1

A. S. MACMILLAN, M.D.,
Boston, Mass.

3. *The film reading session* will consider conditions met in a hospital devoted to treatment of the sinuses, mastoids and abnormalities of the esophagus. Rare and unusual conditions are often emphasized in a presentation such as this, with failure to give adequate consideration to the more common types of pathology met with every day. This discussion will deal with the more commonly encountered abnormalities in which roentgenologic assistance is sought.

The new projector developed by Doctors Dillon and Murphy which makes it possible to show four original roentgenograms of the sinuses at one time will be used.

COURSE 414

Room 738 Period: W-2

EDWARD B. D. NEUHAUSER, M.D.,
Boston, Mass.

The Roentgen Diagnosis of Congenital Cardiovascular Abnormalities Amenable to Surgery

Many forms of congenital malformation of the heart and great vessels, long considered of academic interest only, are now surgically correctible. Recent advances in roentgen diagnosis and in surgical techniques are leading to the recognition of abnormalities which have been overlooked in the past, and have led to the more accurate diagnosis of many malformations whose major features have long been known.

The roentgen features of patent ductus arteriosus, coarctation of the aorta, stenosis of the pulmonary artery, tetralogy of Fallot, Corvisart's complex, double aortic arch, vascular rings constricting the trachea and esophagus, and anomalies of the right subclavian artery and of the innominate vein should be familiar to all roentgenologists. The diagnostic criteria of these malformations will be discussed.

COURSE 415

Room 732 Period: W-2

LESTER W. PAUL, M.D.,
Madison, Wisc.

The Roentgenology of the Rheumatic Diseases

This course will include a discussion of the role of roentgen examination in the diagnosis of the various diseases of the joints and periarticular structures. A classification of arthritis suitable for both roentgen and clinical use will be given. The pathologic basis for the changes visualized by roentgen examination will be covered briefly. Major emphasis in the course will be placed upon the correlation of the roentgenologic and clinical manifestations of the various types of joint disease, and upon the roentgenologic signs by which these types are distinguished from each other, and by which progression from early to late stages is followed.

COURSE 416

Room 732 Period: F-1

HAROLD O. PETERSON, M.D.,
St. Paul, Minn.

Roentgen Examination of the Urinary Tract

The material for this course has been taken from an active urologic service at the Miller Hospital in St. Paul. The material will be supplemented by cases from the University of Minnesota Hospitals. The greater part of the course will deal with intravenous or excretion urography. The routine procedures will be thoroughly discussed, including the preparation

of the patient, use of cathartics, pitressin, dehydration, type of contrast media used, compression, time interval for films, position of patient, etc. In addition to the normal variations, an attempt will be made to cover most of the lesions of the urinary tract and some of the congenital anomalies which can be recognized by intravenous urography. Emphasis will be placed on practical procedures and on the urologic diseases more commonly encountered, rather than on theoretical considerations. Original roentgenograms will be used for illustration with the use of a special projector.

COURSE 417

Room 738 Period: T-1

L. R. SANTE, M.D., St. Louis, Mo.

The Minute Anatomy and Physiology of the Lung; Its Behavior in Health and Disease

The anatomical relationship, and the correlation of function, of the minute structures of the lung is an arrangement which is probably more intricate than any found elsewhere in the body. The balance of physical forces brought to bear upon the lung structures in the physiology of normal respiration, and the safeguards against interference with this function during disease, are remarkable.

A study of the pathogenesis of diseases of the lungs and correlation of the microscopic and roentgenological findings in these conditions should lead to a clearer understanding of both methods of examination.

Such correlated studies will be presented in a number of pulmonary diseases: atelectasis, emphysema, pulmonary congestion, pulmonary edema, drug reactions, pneumonia, etc.

As a result of the behavior of the lung structures under such disease conditions certain disputed points in the minute anatomy and function of the lung may be clarified.

COURSE 418

Room 706 Period: W-1

RICHARD SCHATZKI, M.D., Cambridge, Mass.

Roentgen Examination in Certain Abnormalities of the Esophagus

Technique
Normal esophagus
Curling
Scleroderma
Varices
Cancer
Extramucosal lesions

COURSE 419

Room 744 Period: W-2

WENDELL G. SCOTT, M.D., St. Louis, Mo.

Low Back Pain: An Evaluation of Present-Day Concepts

Various concepts and conditions have been described by orthopedists as a cause of low back pain. In the past years these have been popularized and have enjoyed a vogue almost as volatile as fashions. They are briefly reviewed in the light of present-day knowledge.

Lantern slides will be used to illustrate various conditions which cause low back pain and which can be demonstrated by roentgenographic means. The discussion will include references to the different roentgenographic techniques used in the examination of patients with low back pain.

COURSE 420

Room 732 Period: T-1

PAUL C. SWENSON, M.D., Philadelphia, Pa.

Diagnostic Procedures in the Study of the Large Intestine

This course will deal with all methods now used in roentgenography. An attempt will be made to include all practical procedures used in most hospitals and clinics, with a discussion of the conditions known to be amenable to roentgen diagnosis.

COURSE 421

Room 736 Period: F-2

BARTON R. YOUNG, M.D., *Philadelphia, Pa.*

Roentgen Diagnosis of Diseases of the Air and Food Passages of the Neck; Planigraphy of the Larynx

The normal roentgen anatomy of the soft tissues of the air and food passages is reviewed in detail in the first part of the course. Roentgenoscopy is an indispensable preliminary procedure, so considerable time is devoted to a discussion of this part of the examination. The disturbances in deglutition due to tumor, infection or faulty innervation and the altered physiology and morphology of the larynx that result from any one of these conditions are readily detected by roentgenoscopic examination, and the roentgenoscopic appearances of some of the more common lesions are shown.

The changes in the air and food passages produced by foreign bodies and inflammatory and neoplastic

diseases are demonstrated by exhibiting non-planigraphic and planigraphic roentgenograms. A technique for obtaining posteroanterior studies using non-planigraphic methods is outlined, and the value of this procedure for lateralizing laryngeal lesions is emphasized by showing illustrative cases.

The indications for body section roentgenography, and the results obtained from the application to the neck are presented. Planigraphy is of maximum value in the demonstration of tumors of the larynx but its superiority to conventional roentgen methods is not limited to the larynx. The planigraphic appearance of a number of interesting lesions in the larynx and cervical trachea is shown and discussed

Section on Instruction

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	Course No.	Instructor	Course No.	Instructor	Course No.	Instructor
Tuesday	1					
Wednesday	1					
	2					
Thursday	1					
Friday	1					
	2					

Previous to September 4, 1948, send this order sheet to:

DR. HARRY M. WEBER, MAYO CLINIC, ROCHESTER, MINNESOTA.

After September 4, 1948, mail to:

DR. HARRY M. WEBER, American Roentgen Ray Society, Palmer House, Chicago, Illinois.

CONDENSED SCHEDULE OF COURSES ON TUESDAY, SEPT. 14

Code: T-1	Single Period—8:30 to 9:30 A.M.		Code: T-1
417—Sante	The Minute Anatomy and Physiology of the Lung	101—Williams	The Nature and Production of Radiosotopes
S-1—Hewitt	Suggestions Concerning the Writing and Presentation of Medical Papers	306—Lenz	Radiotherapy of Ocular Lesions
420—Swenson	Diagnostic Procedures in the Study of the Large Intestine	305—Leddy	Roentgen Therapy for Carcinoma of the Breast
402—Childe	The Normal Encephalogram and *Ventriculogram*	409—Holt	The Mechanisms of Skeletal Growth
405—Doub	Myelography	201—Braestrup	Common Causes of Radiation Hazards in Radiology

CONDENSED SCHEDULE OF COURSES ON WEDNESDAY, SEPT. 15

Code: W-1	1st Period—8:30 to 9:20 A.M.		Code: W-1
B—Golden	Roentgenology of the Small Intestine	102—Quimby	Dosage Problems in the Use of Radioactive Isotopes
D—Rigler	Roentgen Manifestations of Bronchogenic Tumors	418—Schatzki	Roentgen Examination in Certain Abnormalities of the Esophagus
406—Good	The Small Intestine	E—Snow	Roentgen Study of Pregnancy
403—Childe	The Pneumographic Diagnosis of Expanding, Contracting and Atrophic Intracranial Lesions	S-2—Fuchs	Influence of Exposure Factors on Roentgenographic Quality
411—Macmillan	Roentgen Examination of the Sinuses	204—Taylor	High Voltage Generators

Code: W-2	2nd Period—9:30 to 10:30 A.M.		Code: W-2
414—Neuhauser	The Roentgen Diagnosis of Congenital Cardiovascular Abnormalities Amenable to Surgery	310—Jacox	Complications following Irradiation of the Pelvis
D—Rigler	Roentgen Manifestations of Bronchogenic Tumors	308—Martin	Complete Care of Cancer of Mouth and Lip Including Cervical Metastases with Irradiation Alone
415—Paul	The Roentgenology of the Rheumatic Diseases	E—Snow	Roentgen Study of Pregnancy
404—Donaldson	The Early Diagnosis of Gastric Cancer	S-2—Fuchs	Influence of Exposure Factors on Roentgenographic Quality
419—Scott	Low Back Pain: an Evaluation of Present-day Concepts	205—Weatherwax	Factors Affecting Roentgen-Ray Dosage

CONDENSED SCHEDULE OF COURSES ON THURSDAY, SEPT. 16

Code: Th-1	Single Period—8:30 to 9:30 A.M.		Code: Th-1
B—Golden	Roentgenology of the Small Intestine	103—Hamilton	The Clinical Applications of Radioactive Iodine
F—Wyatt Randall	Benign and Malignant Lesions of Bone	C—Peirce	Bronchography
311—Widmann	Radiation Therapy in Cancer of the Skin	301—Eberhard	Treatment of Leukemias and Lymphomas
A—Bromer	The Differential Diagnosis of Skeletal Changes Occurring in Diseases of Infants and Children	401—Austin	Interpretation of the Dental Roentgenogram
412—Macmillan	Roentgen Examination of the Mastoids	203—Taft	Dosage Measurement from a Clinical Standpoint

CONDENSED SCHEDULE OF COURSES ON FRIDAY, SEPT. 17

Code: F-1	1st Period—8:30 to 9:20 A.M.		Code: F-1
E—Golden	Roentgenology of the Small Intestine	104—Corrigan	The Practical Use of Tracer Isotopes
F—Wyatt Randall	Benign and Malignant Lesions of Bone	C—Peirce	Bronchography
416—Peterson	Roentgen Examination of the Urinary Tract	304—Lampe	Radiation Therapy of Selected Miscellaneous Nonmalignant Conditions
A—Bromer	The Differential Diagnosis of Skeletal Changes Occurring in Diseases of Infants and Children	S-2—Fuchs	Influence of Exposure Factors on Roentgenographic Quality
412—Macmillan	Film Reading Session	303—Fricke	Radium Therapy for the Less Common Malignant and Non-Malignant Conditions

Code: F-2	2nd Period—9:30 to 10:30 A.M.		Code: F-2
410—Kirklin	Newer Developments in Cholecystography	105—Reinhard	The Treatment of Blood Dyscransias and Malignant Lymphomas with Radioactive Phosphorus, Radioactive Sodium, and Colloidal Preparations of Various Radioactive Isotopes
408—Hodges	Intracranial Angiography	302—Ernst	Practical Concepts of Radiation Treatment of Carcinoma of the Cervix Uteri
407—Hare	Recent Studies on Certain Intracranial Measurements	309—Portmann	Contact Roentgen Therapy for Superficial Lesions
421—Young	Roentgen Diagnosis of Diseases of the Air and Food Passages of the Neck; Planigraphy of the Larynx	S-2—Fuchs	Influence of Exposure Factors on Roentgenographic Quality
307—Leucutia	Comparison of 200 kv. and Supervoltage Roentgen Therapy	206—Weatherwax	Factors Affecting Radium Dosage

DEPARTMENT OF TECHNIQUE

Department Editor: ROBERT B. TAFT, M.D., B.S., M.A., 103 Rutledge Ave. Charleston, S. C.

ON THE UTILIZATION OF THE OPTIMUM PRIME FACTORS IN SPOT ROENTGENOGRAPHY

WITH SPECIAL REFERENCE TO GASTROINTESTINAL ROENTGENOGRAPHY

By A. M. McNABB, M.D.
Medical Arts Building

AND

ISAAC L. NEWTON
National Research Laboratories
OTTAWA, CANADA

THE three prime factors in producing roentgenograms of the highest quality are:

(1) Sharpness of detail controlled by
 (a) Focal spot size
 (b) Focal film distance
 (c) Speed of exposure
 (d) Object film distance
(2) Degree of contrast controlled by
 (a) Kilovoltage used
 (b) Elimination of secondary radiation
(3) Uniformity of density controlled by
 (a) Total radiant energy reaching the film
 (b) Time-temperature processing of the film

Roentgenography of the gastrointestinal tract as routinely done leaves much to be desired. Present equipment generally comprises a stationary anode tube with a fixed focal spot of some 3.6 or more millimeters in diameter, possibly a fixed filter grid, and in most cases an absolute timer of a synchronous motor driven type. As a current of 100 milliamperes is about the maximum consistent with tube life, the focal film distance is relatively short. Each of these items adversely affects the quality of the roentgenogram. Inasmuch as the focal spot is comparatively coarse and the focal film distance short, fine detail is lost. Moreover at the milliamperage available a compromise must be struck between detail and contrast. To improve contrast a reduction in kilovoltage would lengthen the exposure time, as would also the use of a stationary filter grid. Over and above this increased exposure time with the added likelihood of movement, there is the objectionable evidence of grid lines. Uniformity of density can only be obtained by frequent adjustment of an absolute timer from patient to patient, and from position to position. Resulting errors in judgment frequently require departure from routine time-temperature development in order to maintain uniform density.

Three basic improvements must therefore be made if results of improved quality are to be obtained:

(1) The tube must be capable of passing a much higher milliamperage and must have a smaller focal spot.

(2) A moving grid must be substituted for the fixed grid on the roentgenoscopic screen assembly.

(3) The timer must automatically control the total radiant energy reaching the film and be independent of the body build and position of the patient.

This paper outlines in a general way our experience in adding these improvements

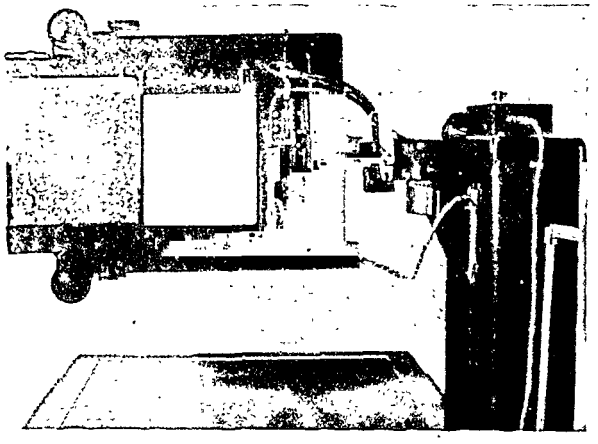


FIG. 1. Screen carriage assembly showing cassette in place, roentgenoscopic screen, photoelectric tube above screen; photoelectric sensitivity control is on top of standard—right.

to a stock motor driven tilt table. The tube selected was a compactly designed rotating anode type with a focal spot of 2 mm. The energy used for roentgenography is 250 ma. and that used for roentgenoscopy with the anode at rest is usually 3 ma. The latter has been found quite sufficient when used at 80 to 90 kilovolts (peak). As the tube is the shockproof cable type, requiring no consideration for high voltage clearance, it was found possible to increase the anode film distance without affecting the travel of the carriage in any way. The anode is now 26 inches behind the table top compared with an original 22 inches, and a maximum focal film distance of 36 inches is possible with the screen at full extension. The installation of a fan inside the table increases the heat dissipation and permits almost continuous operation for all practical purposes.

The decrease in the size of the focal spot and the longer focal film distance, combined with the shorter exposure time made possible by the increased power, made a noteworthy improvement in detail. The increased power in association with a reduction in kilovoltage during roentgenography likewise improved contrast, but not to the degree desired in obese subjects, or in extreme oblique projections. A stationary grid gave satisfactory contrast but the grid lines were considered objectionable under certain circumstances, especially in views of the cap where fine rugae detail was wanted.

A moving grid was designed which has a light mechanism operating in all positions of the tilt table, and no manual presetting is needed as to position or time between exposures. The apparatus consists of a thin focussed wafer grid mounted on linear springs. During roentgenoscopy the grid is stationary with the springs under maximum tension. For roentgenography the movement of the cassette across the tray trips the spring retaining catch. The grid then oscillates with a decaying amplitude of a damped wave type. Withdrawal of the cassette again resets the springs on tension. By such an arrangement it is theoretically impossible to superimpose one line image on top of another, and the period of vibration is such that all desired exposure times are taken care of. In practice, the grid lines are suppressed entirely on most roentgenograms and at no time are they prominent.

The tray on which the grid is mounted replaces the standard roentgenoscopic screen, and being of approximately the same size and weight, no major alterations were required. The left of the tray serves as a receptacle for the unexposed film and is protected by lead. On the right there is an 8 by 10 inch roentgenoscopic screen and the grid is housed on the patient's side of the screen with a tunnel the depth of the cassette between. In the space between the tunnel and the grid, a sliding mask is incorporated. This arrangement permits a choice of a single 8 by 10 inch exposure, or of two 4 by 10 inch or four 4 by 5 inch exposures on an 8 by 10 inch film. A cone for pressure is also placed on the patient's side of the device, and both cone and mask may be readily moved into place by convenient controls. To obtain a roentgenographic exposure, the cassette is moved across under the screen, and as it travels a small lever is elevated by the top of the cassette. This lever promptly trips the grid, closes a micro switch, and through a series of relays energizes the timer, boosts the valve and tube filament current, starts

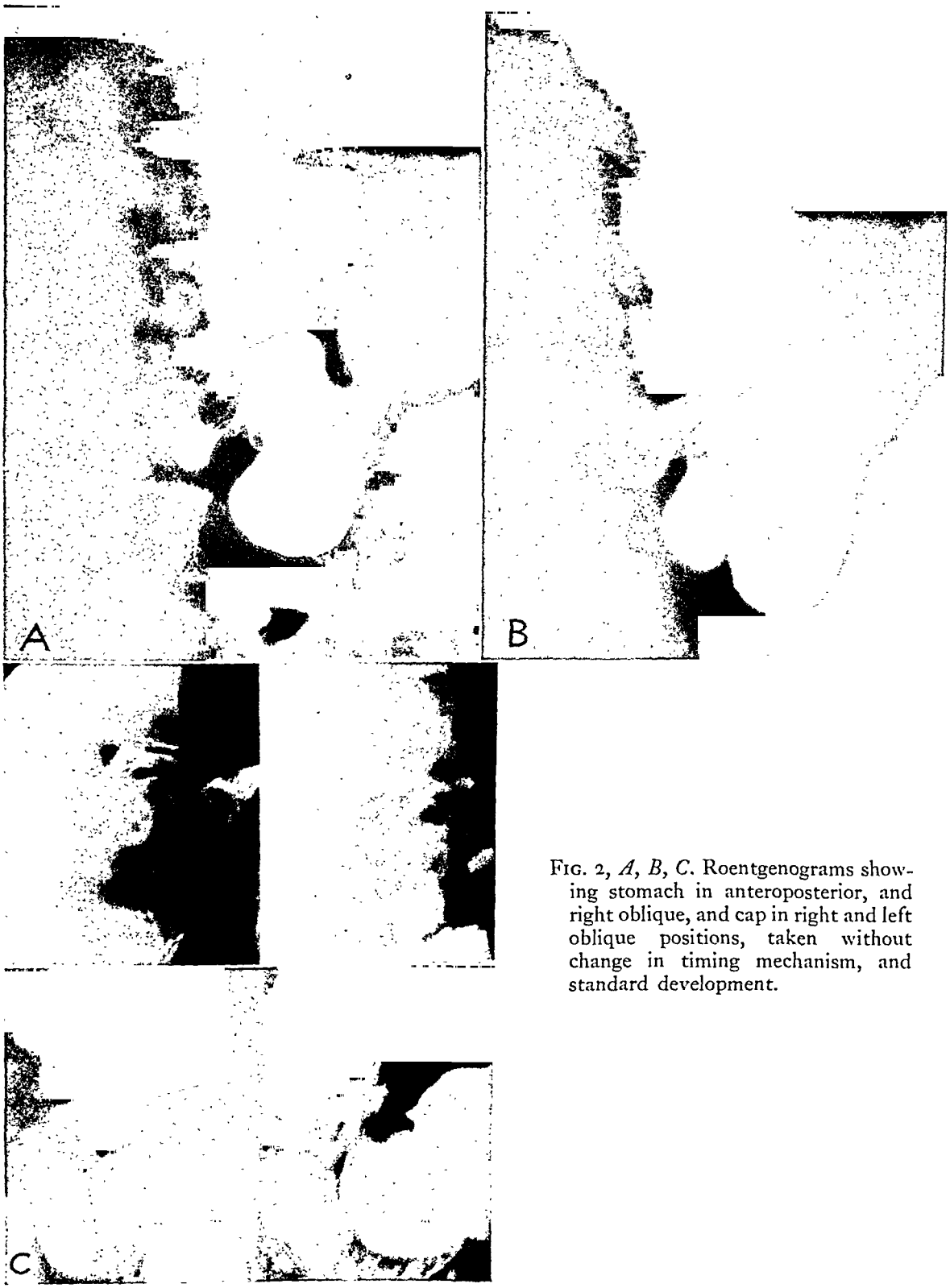


Fig. 2, *A*, *B*, *C*. Roentgenograms showing stomach in anteroposterior, and right oblique, and cap in right and left oblique positions, taken without change in timing mechanism, and standard development.

the rotor, and in the course of less than a second an exposure of 250 ma. is initiated for the proper period of time.

Benefiting from the work of Morgan in his development of a photoelectric cell type of timer, it was found possible to adopt the device and thus control the amount of radiant energy reaching the film, largely

irrespective of the body build or position of the patient. The photoelectric cell was mounted at the top left of the roentgenoscopic screen, and in this position the exposure is quite accurately controlled by the fluorescent image on the screen during roentgenography.

As already noted by Morgan, the sensitivity of the photoelectric timer does not entirely parallel film sensitivity under all conditions, particularly with extremes in body thickness, or with marked change in kilovoltage. We have also found that different structures show up better at different film densities. The gallbladder, for example, seems clearer on lighter films and using a lower kilovoltage than we would employ for the stomach. For these reasons, and for others inherent in the timer design, part of the mechanism was placed on the right of the roentgenoscopic carriage. A small control knob convenient to the hand of the operator, with a pointer easily felt in the darkened room, enables tube sensitivity to be changed and any required film density readily obtained.

The apparatus as described has been chiefly used in gastrointestinal work. To a lesser extent it has been used to obtain a permanent record of any roentgenoscopic examination, including such parts as the gallbladder in the standing position, the lungs, spine, foreign body localization, and fractures. The roentgenograms possess satisfactory detail, good contrast, and compare favorably with those of similar regions made with a standard diaphragm at a comparable focal film distance. The largely automatic timing, associated with the added convenient manual adjustment described, enables such roentgenograms to be readily obtained of a wide variety of parts, as well as maintaining routine time-temperature dark room processing.

SUMMARY

The prime factors affecting the quality of roentgenograms have been discussed in relation to apparatus currently available for utilizing roentgenoscopic film technique.

An apparatus has been described which improves the quality of roentgenograms and extends the field of this technique, utilizing:

(1) A rotating anode tube.
(2) A light weight moving grid of original design.
(3) A photoelectric timer of the basic Morgan design.

Medical Arts Building
Ottawa, Canada

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ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

ROENTGEN DIAGNOSIS

HEAD

INGRAHAM, FRANC D., and COBB, CULLY A., JR. Cerebral angiography; a technique using dilute diodrast. *J. Neurosurg.*, Sept., 1947, *4*, 422–434.

Diodrast is a suitable medium for cerebral angiography. It is inert in the body, quickly excreted, and highly soluble. When large quantities of a concentrated solution are used in angiography, reactions attributable to the hypertonicity of the solution may be encountered. To obviate the occurrence of reactions a method of injecting small quantities of dilute solutions of diodrast with a special angiogram needle is presented. The needle is a No. 18 having a curve of about 60 degrees with its bevel on the outer side of the curve. A rounded shoulder 4 mm. above the opening is placed eccentrically so that its plane of contact with the artery when the needle is in place is at an angle of 45 degrees. This allows the shoulder to form a tight seal and to prevent the needle from advancing into the artery. The needle is connected to the syringe through an ordinary three-way stopcock.

The common carotid artery is exposed through a short transverse incision 2 to 3 cm. above the clavicle. A single loop of moist cotton tape is placed around the artery and attached to a hemostat. While gentle traction is made, the angiogram needle is inserted about 2 mm. above the tape with the stopcock in the off position. After one of the 10 cc. Yale B-D Lok syringes containing 35 per cent diodrast has been attached to the side arm of the stopcock the anode of the roentgen tube is started in rotation. The stopcock is turned to connect the syringe and needle and a stream of blood entering the syringe demonstrates the patency of the system. The injection of 10 cc. is made in approximately two seconds, and as the 2 cc. mark is crossed the roentgen technician is asked to expose the film. The actual exposure coincides with the completion of the injection. After the roentgenogram is made the valve is turned off and the syringe is disconnected. This procedure is repeated for the stereoscopic duplicate and for an anteroposterior arteriogram. The needle is left in place until the films are developed. It is then withdrawn and pressure is made against the arterial puncture until bleeding stops. The wound is irrigated with saline and closed with interrupted silk sutures.

Diodrast appears to be a safe contrast medium for cerebral angiography in both adults and children when used in this way. Roentgenograms of satisfactory quality are secured and several injections may be made for stereoscopic and anteroposterior projections, and for demonstration of two or more of the four arterial networks of the brain.—*K. K. Latteier.*

PEYTON, WILLIAM T., and SIMMONS, DONALD R. Neurofibromatosis with defect in wall of orbit. *Arch. Neurol. & Psychiat.*, March, 1946, *55*, 248–265.

The concept of this disease has changed radically since von Recklinghausen's description in 1882. The cutaneous tumors and pigmentation are only two manifestations of a congenital defect which may involve any or all of the systems of the body.

The hereditary nature has been conclusively established; the controlling factor is a dominant one which follows regular mendelian principles. Evidence is stated to suggest that the cause of the disease lies in defective germ plasm.

A difference of opinion exists as to the cellular origin of the neurofibroma. Masson attributes it to the sheath of Schwann cells and proposes the term "schwannoma." Penfield and Young believe that the tumor is produced from fibroblasts and preserves the characteristics of connective tissue.

The osseous lesions have been classified under three headings:

1. Scoliosis.
2. Abnormalities of growth of individual bones.
3. Irregularity of outline of bones, ranging from central or subperiosteal cysts to pedunculated subperiosteal tumors.

The bones of the skull are commonly involved. Lesions which have been described are:

bulging of circumscribed areas, peculiar vascular designs, enlargement of the sella, enlargement of the orbit and of the optic canal, various types of gross asymmetry, subperiosteal cysts and "bone atrophy and erosion." Bony defects can be due to destruction of bone by neurofibroma or they can be associated congenital defects. The latter are demonstrated in neurofibromatosis with defect in the orbital wall, inasmuch as there is no orbital tumor present in some instances.

Defects in the wall of the orbit, permitting free communication between the intracranial cavity and the orbit, are not often mentioned in the literature. In a review of the literature, the authors found 20 cases with defects in the wall of the orbit. The present paper reports 5 cases collected over a ten year period and it is suggested that the syndrome is not as rare as the paucity of reports might infer.

Temporal or parietal bossing has been reported as one of the common changes in the skull associated with neurofibromatosis. This condition was noted in 4 of the 5 cases observed by the authors, the roentgenograms showing bulging in the temporal region on the side of the tumor. Roentgen evidence of increased pressure is seen frequently in children. Other types of tumors, both of the brain and of the body in general, are frequently found in association with neurofibromatosis. Thirteen per cent of the neurofibromas undergo malignant change but tumors having no relationship to the neurofibroma are commonly seen. Gliomas and meningiomas are frequently associated with neurofibroma.

Exophthalmos was seen in all of the cases presented in this paper. Two factors may produce this change: (1) the presence of a retrobulbar neurofibroma or an associated tumor such as a glioma of the optic nerve; (2) encroachment on the orbital structures by the intracranial contents which proved to be the chief cause in this series of cases.—*Robert N. Byrne.*

SOULE, ARTHUR B., JR., and WHITCOMB, BENJAMIN B. Extensive erosion of the base of the skull from a leptomeningeal cyst. *Arch. Neurol. & Psychiat.*, April, 1946, *55*, 382–387.

Erosion of the cranial bones from pressure of a leptomeningeal cyst is an uncommon, but not rare, condition. While the majority of such cysts develop after severe trauma to the skull, usually with fracture, there is evidence that congenital abnormalities in the dura and leptomeninges may contribute to their production. These cysts are noted more commonly in the parietal, frontal, and occipital regions.

The reported case is of a twenty-eight year old soldier who was admitted to an Army General Hospital with swelling about the right orbit and temporozygomatic region and with exopthalmos on the same side. Complaints concerning the affected region dated back one and a half years at which time the patient suffered a mild cerebral concussion as a result of an explosion. One year later, roentgenograms demonstrated cystic changes in the right anterior temporal region and in the walls of the orbit. A tentative diagnosis of cystic bone tumor or a vascular neoplasm was made. He was evacuated to the United States. A repeat examination revealed extensive destruction of bone in the middle cranial fossa with complete erosion of both tables of the skull and herniation of the cyst into the pericranial tissues.

The differential diagnosis discussed included the following possibilities: meningioma; epidermoid tumor or cholesteatoma; osteogenic sarcoma; xanthomatosis; leptomeningeal cyst; myeloma; metastatic malignant disease; localized osteitis fibrosa cystica.

Successful operative interference was carried out and the operative findings are described. The concluding comment includes several opinions as to the mechanics of origin of these cysts.—*Robert N. Byrne.*

NECK AND CHEST

BRADSFORD, MARTIN L., MAHON, HUGH W., and GROW, JOHN B. Mediastinal cysts and tumors. *Surg., Gynec. & Obst.*, Oct., 1947, *85*, 467–494.

The authors emphasize, as does John Alexander, "The majority of circumscribed intrathoracic neoplasms arise within the lung (almost all of them being malignant); many of those that arise outside of the lung are malignant; and, therefore, the prompt removal of any circumscribed neoplasm which cannot be proved benign is of vital importance."

Congenital Cysts

Epidermoid cysts, dermoid cysts and teratomas. Epidermoid is the simplest of the cysts lined by stratified squamous epithelium supported by fibrous tissue and its contents are desquamated

and degenerated epithelial cells. Dermoid cysts are lined by stratified squamous epithelium with added elements in their walls of structures ordinarily arising from skin; sebaceous glands, coil glands, hair and teeth. The teratomas include elements of all three layers so that all structures of the epidermoid or dermoid may be present plus ciliated and cylindrical cell structures of gut or respiratory tract origin; muscle, bone, cartilage, lymphoid tissue, brain and thyroid.

Pericardial celomic cysts. This type of cyst is thin-walled and contains clear fluid. The so-called "spring water" cyst may be included under this heading.

Bronchial cysts of the mediastinum. These congenital cysts of the mediastinum are characterized by ciliated columnar epithelium in their lining membranes. Cartilage and smooth muscle bundles are often present in their walls.

Esophageal cysts and gastroenteric cysts. Those cysts included within the muscularis of the esophagus can be called esophageal cysts; those located in the rest of the mediastinum or lung can be of bronchial origin. Gastroenteric cysts are rare. They are characterized by the resemblance to gastric and intestinal structures.

Cystic lymphangiomas. These cysts are also called "cystic hygromas." They are very rare in the mediastinum and are characterized by multiloculated cysts containing fluid with an endothelial lining and smooth muscle and lymphocytes in the walls.

Connective Tissue Tumors

Fibromas. This is a rare lesion. It is usually "silent" for years.

Lipomas. Most of the intrathoracic lipomas originate in the mediastinum. They may attain giant size and cause death from pressure.

Leiomyomas. Many of the intramural extramucosal tumors of the esophagus are leiomyomas. It is important to remove these growths because of the possibility of sarcomatous degeneration.

Xanthomas. It is questionable that these tumors should be considered as a separate type.

Chondromas, chondromyxomas, chondromyxosarcomas. These tumors originate from cartilage which is found adjacent to the mediastinum in the sternum, costal cartilages, and articular surfaces of the spine and costovertebral junctions. They are important in that they attain great size and may metastasize even though benign on microscopic section.

Neurogenic Tumors

These tumors arise from the sympathetic nervous chain or its anlagen.

Neurofibromas. These tumors are thought to come from the perineurial or endoneurial fibrous tissue and are distinguished from the tumors of the sheath of Schwann which are characterized by elongated fusiform cells with "pallisading" of the nuclei.

Ganglioneuromas. Scott and Palmer classified the tumors of the peripheral sympathetic system according to degree of differentiation. Ganglioneuroma lies with pheochromocytomas and astrocytomas in the completely differentiated group. There is a very low tendency toward malignancy.

Primary Tumors of the Thymus

There is considerable confusion regarding classification of the tumors of the thymus.

Benign thymomas. The present knowledge of the relationship between myasthenia gravis and tumors of the thymus is sketchy.

Malignant thymomas. The lymphosarcoma or thymoma, which probably originates from the reticulum cells, is the most common type.

Thymic cyst. This is a rare entity in adults. A few cases have been reported in infants.

Primary Tumors of Lymph Nodes

Lymphosarcomas. Primary sites of lymphosarcoma in order of frequency are: cervical, mediastinal, retroperitoneal and mesenteric nodes.

Hodgkin's disease. Jackson and Parker showed mediastinal or hilar nodes to be involved in 52 per cent of their 174 cases of Hodgkin's granuloma, with one-third of the cases of Hodgkin's sarcoma showing involvement.

Boeck's sarcoid. Boeck's sarcoid is a pitfall in the common practice of using a "test dose" of deep roentgen therapy to establish the diagnosis of "malignant lymphoma." Riesner states that over 85 per cent of 35 cases showed mediastinal node involvement, and that 6 of these cases showed practically complete disappearance of the shadows while being watched; half of the total showed some regression.

Endotheliomas. This is a rare type of primary tumor of the lymph nodes.

Primary and Secondary Sarcomas

Any of the connective tissue in the medi-

astinum may be the site of sarcomatous growth. Unfortunately, there is no way to distinguish between the benign mediastinal tumors and the malignant on roentgen examination. Total removal is possible in early cases and metastasis is usually late.

Secondary sarcomas of the mediastinum are extremely rare as hematogenous spread is more frequent, therefore involving the lungs before the mediastinum.

Primary and Secondary Carcinomas

The most frequent origin of primary carcinoma of the mediastinum is the thymus. Primary sarcomas are three to four times as frequent as primary carcinomas.

Secondary carcinomas of the mediastinum usually come from lung, esophagus or breast, and occasionally from abdominal viscera.—*Mary Frances Vastine.*

Ecker, Arthur, and Chamberlain, Richard H. An additional approach to the internal carotid artery for cerebral angiography. *J. Neurosurg.*, Sept., 1947, *4*, 444–450.

The purpose of this paper is to describe an additional site through which roentgenographic contrast medium may be introduced into the internal carotid artery. The site described is immediately below the carotid foramen at the base of the skull. Here the internal carotid artery is relatively fixed because of the proximity to its bony canal.

The point of entry of the spinal needle is chosen on the skin 3 mm. anterior to the posterior edge of the ascending ramus of the mandible at the point where the latter is most concave. The needle is directed upward and medially in relation to the skull and backward in line with the center of the external auditory canal. It must pass through a triangle of bone bounded by the styloid process below, the ascending ramus of the mandible in front, and the tympanic plate above. When the needle passes through the wall of the artery, a definite "give" may be felt, but it is frequently necessary to strike the medial wall of the carotid foramen and then withdraw the needle very slowly until arterial blood gushes forth. It is then in the proper position in the internal carotid artery. The injection should be made quickly so that 10 cc. of 35 per cent diodrast is placed within the artery in less than three seconds.

The authors first attempt percutaneous injection of the common carotid artery and if this procedure is unsuccessful, injection of the internal carotid as described is the next procedure of choice. Should this method also be unsatisfactory, direct exposure of the carotid is then employed.

The authors are also aware of disadvantage of the method described, and advise against the use of thorotrast as a contrast medium because of the danger of extravasation. However, the high injection site allows use of low concentration contrast medium with reduced total amount of medium employed, and the advantage of direct injection into the internal carotid artery.—*K. K. Latteier.*

Görgényi-Göttche, O., and Kassay, D. The importance of bronchial rupture in tuberculosis of endothoracic lymph nodes. *Am. J. Dis. Child.*, August, 1947, *74*, 166–206.

The authors agree with Rössle who believed that the shadows known previously as "epituberculosis" in the lungs were nothing but the roentgen picture of atelectasis. They trace the reports in the literature since 1919 when Kleinschmidt observed large shadows in the lungs of tuberculous children which disappeared later without trace. In 1920, Eliasberg and Neuland considered these shadows regressive and harmless and named them epituberculous infiltrations.

In this paper, 12 cases are reported in detail, all of which have reproductions of the roentgenographic findings. In addition to the usual roentgenograms of the chest, tomography was employed in the examination of the patients. This best demonstrated the trachea, the main bronchi and even the smaller bronchi. Twenty-eight cases were subjected to bronchoscopy. In 18, there was evidence of rupture of a lymph node into a bronchus; in 3, encroachment on a bronchus by a lymph node was demonstrated, and in 7, bronchoscopy was without result. They concluded that a common cause was present in the cases having shadows such as described by Eliasberg and others, namely, rupture of caseous lymph nodes into the bronchi.

In confirmation of their opinion, the authors quote the work of Kálló whose report in more detail will be published later. He found that in 17 cases of tuberculosis in children which came to autopsy, 8, or 47.1 per cent, revealed bronchial rupture. Careful technique at autopsy is required to demonstrate the rupture. Some-

times only a very small opening is found through which the contents of a caseous lymph node expands into the lumen of a bronchus. Many children die of tuberculous meningitis before the stage of bronchial rupture occurs. In 3 of the 17 cases, the primary focus ruptured into a bronchus. In 1 case, a lymph node ruptured into a main bronchus and a double rupture occurred in 2 cases. The sites where the rupture had taken place were as follows: secondary and tertiary bronchi, 6 cases (5 of them lower lobes); primary bronchus, 6 cases (2 into the middle and 2 into the lower lobes); main bronchus, 4 cases and trachea, 1 case. In only 9 cases of the 17 (53.9 per cent) could the location of the rupture have been discovered by means of the bronchoscope.

Bronchi which were examined at autopsy, frequently showed arched lymph nodes which apparently coalesced with the wall of the bronchus, and while destroying it, they encroached on the lumen. The encroaching lymph nodes then can be considered the prelude of rupture. Sometimes spontaneous evacuation of the caseous masses within the bronchi can occur.

The clinical signs and symptoms are described in detail. In some, they are striking and alarming, while in others, which are in the majority, they are not pronounced. These, the authors term silent cases.

Among the roentgen signs, those of atelectasis are important, especially the so-called Holzknecht-Jakobson, sign, namely, the movement of the mediastinum during deep inspiration toward the side of the bronchial stenosis. Obstructive emphysema is an imperative indication for bronchoscopy.—*R. S. Bromer.*

Fagin, I. Donald, and Schwab, Edward H. Spontaneous mediastinal emphysema. *Ann. Int. Med.*, June, 1946, *24*, 1052–1072.

Three patients with spontaneous mediastinal emphysema are reported. The pathogenesis and clinical features of the condition are discussed in detail.

The present conception of spontaneous mediastinal emphysema is that air leaks from alveoli into perivascular connective tissue and thence into the hila and mediastinum. This postulates a defect in alveolar walls due to emphysema or disease which allows air to reach the sheaths of pulmonary blood vessels. The pumping action of respiration, due to lengthening and shortening of the pulmonary vessels, forces air along these perivascular sheaths to the mediastinum. Under certain conditions, the distended sheaths of the pulmonic blood vessels may cause interference with blood flow and circulatory embarrassment.

Males were affected 12 times as often as females. The average age was twenty-six years. There was no occupational predisposition. In less than one-half of the patients, physical exertion seemed related to the mediastinal emphysema.

Sudden pain was usually the first symptom. The pain often suggested a cardiac accident in onset and distribution. It lasted from a few hours to days.

A peculiar crackling or crunching sensation was often a subjective finding. Dyspnea varied depending upon the degree of associated pulmonary collapse.

Mediastinal crepitation was the characteristic clinical finding. It was audible for periods ranging from hours to six weeks. Sometimes, it varied from day to day being audible once, and not heard later.

Pneumothorax, particularly left sided, was a common occurrence. It occurred more frequently in patients most severely affected.

The roentgenographic evidence of air in the mediastinum clinched the diagnosis. Unfortunately, less than half of the cases revealed air along the cardiac borders or in the anterior mediastinum.

The prognosis was uniformly good in adults. Infants offered a more serious prognosis.

This is a well documented review with an excellent bibliography. —*Philip J. Hodes.*

Fenichel, Nathan M., and Epstein, Bernard S. The clinical and roentgenologic diagnosis of pericardial effusion. *Ann. Int. Med.*, March, 1946, *24*, 401–412.

This is a clinical review of findings in 13 patients with large pericardial collections. All had distended neck veins, hepatic enlargement, and other evidences of cardiac tamponade. All were dyspneic but only 7 were orthopneic.

The authors review the clinical manifestations of pericardial effusion. It was noteworthy that the electrocardiogram was not very helpful.

Diffuse cardiac enlargement was noted roentgenographically in all patients but the "water-bottle" appearance was seen only in six. The most reliable roentgen procedure was repeated observations for evidence of recession or progression in the size of the lesion. Fluoroscopy for differences in amplitude of pulsation

over the heart margins and great vessels was not considered diagnostic.—*Philip J. Hodes.*

ABDOMEN

Lopez-Kruger, Rodolfo, and Dockerty, Malcolm B. Tumors of the islets of Langerhans. *Surg., Gynec. & Obst.*, Oct., 1947, *85*, 495–511.

The authors summarize their article as follows:

1. Asymptomatic islet cell adenomas are more frequent than hitherto believed. Routine examination of 10,314 pancreases revealed 44 such tumors and a carefully conducted study of 500 pancreases disclosed 8 tumors (1.6 per cent).

2. Clinical hypoglycemia originating in neoplastic proliferation of islet cells is a rare disease. Such proliferation can be manifest in 4 ways pathologically: (1) benign adenomas, 70 per cent; (2) islet cell adenomatosis, 2 per cent; (3) histologically malignant but non-metastasizing islet cell tumors, 20 per cent; (4) metastasizing islet cell carcinomas, 8 per cent.

3. Generally productive of a clinical history measured in half decades, the adenomas are small, fairly well encapsulated nodules with high degrees of cellular differentiation and no mitosis. The histologically malignant or "border-line" tumors are, on the average, twice the size of the adenomas and are more vascular and more invasive. The presence of cellular atypia, hyperchromatism, and mitosis is that of grade 1 (Broders) order of malignancy and is paralleled in a general way with a relatively short clinical history. The possibility of metastasis should be considered in members of this group in which vascular invasion is present. Measured in clinical terms of months rather than years and sometimes of production of a paradoxical gain in weight, metastasizing islet cell carcinomas demonstrate a large size, gross invasive tendencies and metastasis with microscopic evidence of manifestly malignant cells and vascular invasion. In all of the groups positive results using special staining methods will be obtained in some but not all of the tumors. The results do not justify the conclusion that functioning pancreatic insular tumors are beta cell neoplasms.

4. Statistically speaking, the surgeon can expect to find a tumor in from 50 to 60 per cent of the cases on the first exploration. The presence of multiple tumors (10 to 15 per cent in the border-line and the metastasizing malignant groups) will sometimes decide the necessity of repeated operations in search for the causative tumor (persistence of hypoglycemia after partial pancreatectomy for hyperfunctioning tumor). "Blind" resection of the tail of the pancreas will remove 50 per cent of the tumors; resection of the body as well as the tail will account for about 20 per cent more. Total pancreatectomy will occasionally be necessary for some of the small buried tumors located in the head of the gland, which is the site of about 20 to 30 per cent of the neoplasms. Very rarely (1 to 2 per cent) the tumor will have an extrapancreatic location.

5. The surgeon performing an operation for the relief of hypoglycemia must be prepared to carry out procedures ranging all the way from simple excision of an easily identified and readily shelled out tumor to total pancreatectomy. These procedures are justified by the complete failure of medical treatment of organic hypoglycemia.—*Mary Francis Vastine.*

Jackman, Raymond J., Neibling, Harold A., and Waugh, John M. Carcinoma of the large intestine *J.A.M.A.*, Aug. 16, 1947, *134*, 1287–1289.

A study of the records of all patients with carcinoma of the colon and rectum who came to the Mayo Clinic during the year 1944 was made. There were 817 patients in the group with a total of 825 lesions. The purpose of the study was to determine the nature of the treatment in relation to the location of the carcinoma. More specifically, the study consisted in considerations on (1) how many carcinomas of the large intestine within reach of the examining finger are diagnosed and treated as some other disease during the course of the patient's symptoms, the carcinoma remaining undiscovered; (2) how many additional carcinomas which should have been visible at sigmoidoscopic examination are erroneously treated, and the nature of the treatment; (3) how many carcinomas discernible in roentgenograms of the colon likewise are erroneously treated, and the nature of the treatment, and (4) how many carcinomas of the large intestine are discovered only at surgical abdominal exploration.

In the group studied, more than half (54.3 per cent) of all patients with carcinoma in any part of the large intestine had lesions which could be palpated by digital examinations of the rectum. About one-fourth (23 per cent) of the patients in this group had received some form of treatment for disease of the colon or

rectum, but not for carcinoma, during the course of their symptoms arising from the unsuspected carcinoma that was within reach of the examining finger. An additional 16.2 per cent of all the patients who had carcinomas anywhere in the large intestine had lesions which were within reach of the sigmoidoscope. One-fourth (25.8 per cent) of this group had rereceived treatment for some disease other than carcinoma, which had remained undiscovered. Patients who had carcinomas of the large intestine that were beyond the reach of the examining finger and sigmoidoscope constituted the remaining 29.5 per cent of the total series of 817. Of this group 28.4 per cent had carcinomas that were diagnosed by roentgenologic studies of the colon, and 1.1 per cent had lesions that were discovered at abdominal surgical exploration. In this group, during the period of symptoms from carcinoma, only 9.9 per cent of the patients had received treatment directed toward any other condition.—*Samuel G. Henderson.*

CROHN, BURRILL B., GARLOCK, JOHN H., and YARNIS, HARRY. Right-sided (regional) colitis. *J.A.M.A.*, May 24, 1947, *134*, 334–338.

Eight per cent of all cases of ulcerative colitis of the nonspecific type are regional or right sided in anatomic distribution. In this subgroup the pathologic process begins and is commonly limited to a segment or segments of the proximal colon; its life history is characterized by a progressive march to the left, until by skip lesion or by continuity the whole colon from cecum to sigmoid may become interruptedly or continuously involved. Clinically right-sided or regional or segmental colitis is less severe in its local signs and symptoms than is universal or left-sided colitis with its predominantly rectal involvement; that is the diarrhea, the urgency, the staining and the bloody stools are less pronounced. On the other hand, the constitutional manifestations are more apparent and are characterized by fever, often continuous, by manifestations referable to the joints, ocular complications and occasional implication of the valves of the heart.

This study comprises 77 cases of right-sided or segmental colitis under observation between the years 1928 and the present date. The causation of this form of colitis is as little specific or known as that of colitis in general or of ileitis. The average age at the time of study has been 27.3 years. The pathologic process involves one or many of the segments of the colon in its progressive course except the rectum.

The clinical manifestations of segmental colitis are both local in the intestinal tract and general throughout the body. Locally the disease is characterized by diarrhea which is rather moderate in severity. Fever, ranging from 101 to 105°F., is irregular, lower in the morning and higher at night and not continuous and sustained but irregular and peaked. The leukocyte count is usually low or only slightly elevated (8,000 or 12,000 to 15,000). Single, but more often multiple joint involvement is common. Any of many of the larger joints may be affected; the smaller joints, particularly of the hand, are frequently the site of periarticular inflammation. One of the less frequent but characteristic complications is involvement of the eye as part of a focal infection. Phlyctenular conjunctivitis, iritis, keratitis, and uveitis constitute the commoner forms. In one case there was noted an acute endocarditis, with fever and a blowing systolic apical murmur developing under observation. In this series erythema nodosum occurred twice, the rash being identical with that on the extremities so commonly observed in the severe types of universal colitis.

The roentgenograms taken after after a barium enema demonstrate disturbed mucosal pattern, irregular and moth-eaten borders of the outline of the colon, foreshortening of the lumen and absence of haustral markings in the affected segments of the large bowel. When diarrhea is minimal and when fever, articular manifestation and ocular complications (iritis, uveitis) are the obvious clinical symptoms, it is easy to understand why so frequently these cases are mistaken for chronic rheumatic fever, for Libman-Sacks disease, brucellosis or periarteritis nodosa. The leukocyte count is generally low in all of these clinical conditions; the fever is similarly frequently continuous or irregular in type.

Where the patients choose and insist on conservative therapy, retention enemas of neutral acriflavine at bedtime, chemotherapy and intramuscular injections of liver extract and vitamin B complex are used. The treatment of choice is surgical. Ileosigmoidostomy with subsequent subtotal colectomy was performed in the majority of 58 patients selected for operation. There was a 20 per cent mortality. Forty-three of these remained well, while 3 have developed subsequent disease in the rectrum.—*S. G. Henderson.*

GYNECOLOGY AND OBSTETRICS

Ayre, J. Ernest. Cervical cancer; a disordered growth response to inflammation in the presence of estrogen excess and nutritional deficiency. Cytological, clincal, nutritional and pathologic studies. *Am. J. Obst. & Gynec.*, Sept., 1947, *54*, 363–390.

Evidence that a type of human cancer is associated with a metabolic disturbance characterized by a nutritional deficiency, an estrogen excess, and an inflammatory reaction is presented in this article. The inference is that uterine cervical cancer may be the abnormal type of inflammatory response to chronic infection which occurs in the presence of a nutritional deficiency of thiamine and an associated excess of the specific growth-hormone estrogen.

The author summarizes his findings as follows:

1. Cytology studies have been found valuable in early diagnosis of cervical cancer, and in estimating endogenous estrogen.

2. Comparative vaginal and cervical cornification counts have revealed greater concentration of estrogens in the cervix in 87 per cent of cases studied.

3. Some degree of chronic cervicitis is believed to be present in four of five adult cervices.

4. Estrogen-fixation and concentration in infected cervical tissues is believed to be a growth-stimulating factor predisposing to cancer.

5. Evidence of excessive tissue estrogen has been found in 92 per cent of 50 cervical cancers.

6. Deficient urinary thiamine excretion has been found in 86 per cent of 50 cervical cancers. Ten per cent of 50 controls showed the same deficiency.

7. Riboflavin deficiency was found in 38.8 per cent of cancer cases, and in 6.8 per cent of the controls.

8. Studies of cervical biopsies illustrating abnormal growth proliferation in the presence of cervicitis, excess tissue estrogens, and low thiamine excretion are presented.

9. Partly by speculation, partly by interpretation of evidence presented, an attempt is made to correlate infection, excessive tissue estrogens, and nutritional deficiency in the production of cervical carcinoma of the squamous type.

10. The possible concentration of estrogen around cervical cancer lesions arouses great hope for improved therapy with radioactive isotopes. Just as thyroid cancer may succumb to radioactive iodine, so also may the selective affinity of estrogen for proliferating Mullerian tissues enable successful treatment of cancer of the cervix.—*Mary Frances Vastine.*

Pund, Edgar, R., and Auerbach, Stewart H. Preinvasive carcinoma of the cervix uteri. *J.A.M.A.*, July 20, 1947, *134*, 960–963.

The recognition of carcinoma of the cervix in a truly early stage is one of the recent advances in the effort to control the disease. These lesions are being found because a search is being made for them. Ample and concise descriptions of the histopathology are available, and microscopic differentiation from non-cancerous squamous metaplasia has been emphasized. Various opinions as to the malignancy or non-malignancy of such lesions have been expressed by different writers, but the authors' observations have led them to believe that the cells of these disorders are fully neoplastic and will ultimately invade the tissues of the cervix unless eradicated. For this reason they consider the term "pre-invasive carcinoma" as best descriptive of the disease.

This paper represents the study of 1,200 cervices, most of which were from patients on whom total hysterectomies were performed. Representative samples of the entire cervix were obtained by cutting serial blocks from around the junctional area. Preinvasive carcinoma occurred in 47 instances, or in 3.9 per cent of the cervices examined. Hesitancy in the mind of either observer as to the nature of a lesion was sufficient to exclude equivocal cases. No invasive cancers were included, although several early and unsuspected ones were encountered.

The average age was 36.6 years. To determine the average age of noticeably invasive carcinoma of the cervix in women, 50 consecutive biopsies were selected at about the midperiod of this study. The average age was 48.6 years. About 28 per cent of those patients in the group of 1,200 on whom adequate data were available had complained of some form of intermenstrual bleeding. About 80 per cent of the women showed "normal" endocrine function as judged by single endometrial studies.

Wide variation in the gross appearance of the cervix was noted. The most obvious gross feature of the specimens was the absence of evidence of carcinoma. Its presence was not diagnosed from the gross appearance in any case. The neoplasms were located principally or entirely on the gland-bearing portion of the cervical lining, near or at the junction of stratified

squamous and columnar epitheliums. Involvement of the stratified squamous epithelial surface occurred to a notable extent in only 10 of the specimens and probably was attributable to downward growth and replacement rather than to origin on this surface. From the initial focus, possibly foci, the growing cells spread vertically and laterally over the endocervical surface, into the mouths and lumens of the endocervical mucous glands and, inconstantly, downward to displace stratified squamous epithelium of the vaginal aspect of the cervix. Evidence that the remote source of these cancers is the endocervical basal cell is fairly substantial. These groups of cells, which are demonstrable in nearly all human cervices, are capable of non-cancerous multiplication of squamous metaplasia. The location of these cells corresponds to the location of early carcinoma. Morphologically the primitive basal cell groups and the proliferating cell clusters bear a close resemblance to the common small cell surface neoplasms.

The authors believe that early detection by periodic examination offers promise. Screening for cancer by the vaginal smear technique of Papanicolaou and frequent use of biopsy are methods of special merit in view of the occult nature of the initial phases of the disease. If diagnosed in the preinvasive stage the chances of cure are excellent.—*S. G. Henderson.*

GENITOURINARY SYSTEM

RICHARDS, C. E. Visco-Rayopake in cystourethrography. *J. Urol.*, Sept., 1947, *58*, 185–191.

Cystourethrography is useful in the diagnosis of bladder and urethral lesions such as neoplasms, calculi, foreign bodies, fistulae, extravasations, diverticula, strictures and congenital anomalies. This method of diagnosis is particularly valuable where cystoscopy is impossible and to provide a graphic record of disease for later comparison.

The history of cystourethrography and the development of various contrast media is traced by the author. Media which are satisfactory for cystography are usually not sufficiently opaque or viscous for urethrography. The disadvantages of the usual radiopaque media are discussed. These disadvantages include mucosal irritation, non-miscibility with urine and fat embolism.

A new medium, visco-rayopake, is discussed. Its chemical formula and composition is given. The pharmacology and toxicology has been tested adequately and the medium has been found innocuous in reasonable concentration. Visco-rayopake appears to be an ideal medium. Detail is better than provided by any media except the iodized oils and is at least equal to these. The medium is water soluble and freely miscible with urine. There is no risk of fat embolism. If the substance should be introduced into the venous system it is non-toxic.

The author has used visco-rayopake in 54 patients with excellent results. His technique includes adequate preparation of the patient by purgation and enemas and voluntary voiding of all urine possible. A preliminary film of the abdomen is exposed and a 2–4 per cent solution of sodium iodide introduced into the bladder through a urethral catheter. This solution is left in the bladder and the catheter removed. Twenty-five cubic centimeters of rayopake is then injected slowly into the urethra, the last 5 cc. during exposure of the film. An oblique film is then exposed at 45 degrees while another 5 cc. of medium is being injected. The amount and concentration of dye introduced into the bladder depends upon whether it is desired to outline the bladder or depict radiolucent encroachment on the bladder lumen. In the former case larger amounts of the more concentrated solution are used.—*Rolfe M. Harvey.*

BRODNY, M. L., and ROBINS, S. A. The use of a new viscous water-miscible contrast medium Rayopake for cystourethrography. *J. Urol.*, Sept., 1947, *58*, 182–184.

The ideal medium for cystourethrography has not yet been perfected. Solutions of silver salts in adequate concentrations are injurious locally and toxic generally. Aqueous solutions of barium and bismuth leave insoluble particles in the bladder to act as niduses for calculus formation. Adequate concentrations of halogen salts are irritating. Oily preparations such as lipiodol and iodochlorol tend to form globules and interfere with visualization of the bladder base. Oil emboli are also to be feared with these preparations. It has been impossible to make the intravenous urographic media viscid enough for urethrography.

The authors introduce a new substance, rayopake, which has an iodine compound, 2,4-dioxo-3-iodo-6 methyl tetrahydropridine acetic acid, in a viscous base of polyvinyl alcohol. This has an excellent degree of radiopacity, may be diluted at will, being readily miscible with water

or urine, has good viscosity, has not led to embolism, shows no evidence of being a mucosal irritant, does not support bacterial growth and is completely removed by voiding. The authors secured satisfactory roentgenograms in 200 adults and 50 infants on whom the medium was used for cystourethrography.—*Rolfe M. Harvey.*

Silver, H. K. Wilms' tumor (embryoma of the kidney). *J. Pediat.*, Dec., 1947, *31*, 643–650.

This study is based on a series of 18 verified cases of Wilms' tumor. Thirteen cases had nephrectomy and 10 of the 13 are alive from two to fifteen years following therapy.

Wilms' tumor is the commonest abdominal neoplasm in children. Metastasis is by way of direct extension, the lymphatics or the blood stream, but is usually delayed. If complete histopathologic studies are made all characteristic cell types are usually present. The tumor is usually discovered before the age of six. Eleven patients were females and 7 males.

An abdominal mass was the commonest sign or symptom. Abdominal pain was present in half the cases. Urinary symptoms were infrequent. Gross hematuria was present in only 3 cases. The commonest physical finding was of an abdominal mass, solid, non-tender, and smooth in outline. The most difficult condition to differentiate was adrenal neuroblastoma. Other diagnoses to be considered are retroperitoneal sarcoma, polycystic kidney, hydronephrosis, lymphoma, splenic cyst and ovarian cyst.

Seven of 8 cases in whom blood pressure was recorded had hypertension. Pyelography disclosed distortion of the renal pelvis, displacement of the kidneys and ureters, and occasionally a non-visualized kidney pelvis. Aspiration biopsy is contraindicated.

The best type of treatment seems to be nephrectomy plus postoperative irradiation. The advisability of preoperative irradiation is disputed by many. Most authors employ preoperative irradiation only when the tumor is too large for operative removal.

Ladd and White in a summary of the literature in 1941 found 38 probable cures out of 563 reported cases. The authors report a survival rate of 76.9 per cent in 13 cases having nephrectomy. All patients having preoperative roentgen irradiation plus nephrectomy and postoperative roentgen irradiation are still alive (4 cases). The survival time varies from two and a half to fifteen years.—*Rolfe M. Harvey.*

Harvey, N. A. Kidney tumors; clinical and pathological study with special reference to the "hypernephroid" tumor. *J. Urol.*, April, 1947, *57*, 669–692.

The author first reviews the literature regarding hypernephromas. The present, most widely accepted conception of the origin of these tumors is that they arise from renal tissue rather than from adrenal rests. Fifty malignant kidney tumors and 8 incidental "hypernephroid" tumors encountered at the Rhode Island Hospital form the material on which this report is based. Renal tumors constitute 2 per cent of all tumors in adults and 20 per cent of all tumors in children.

In the author's series of kidney tumors 66 per cent originated in the cortex and 26 per cent in the pelvis; 81.5 per cent of the cases occurred in the fifth, sixth, and seventh decades. Seventy per cent of cases were in males. The tumors appeared to have a predilection for the upper pole and a few more cases were found on the left side than on the right. As in all previous reports the author found the symptoms to be protean and bizarre, with symptoms often being referable to metastases. The classical symptoms of pain, swelling and hematuria were present in only 17 per cent of cases. Hematuria was absent in 30–35 per cent of cases. Weight loss was the most common constitutional symptom. Gross hematuria occurred in 59 per cent of cases and microscopic hematuria in 77 per cent.

Roentgenology offers the best chance for early diagnosis. Survey films of the abdomen may reveal enlargement of the kidney, this being noted in 8 of 16 cases with such films in this series. Twenty excretory urograms were made in the present series. In 5 of these 20 the diagnosis could be made from the urogram alone. In 4 of the remaining 15 cases the urograms were of value because ureteropelvic block prevented retrograde study.

The retrograde pyelogram was the more reliable of the two procedures because of the finer detail provided. The commonest intrapelvic abnormality was a filling defect due to pressure on or invasion of the cortex. Elongation or constriction of the calices was frequently seen. The commonest extra pelvic urographic change, besides enlargement of the kidney, was renal and ureteral displacement.

In 20 of 34 cases a definite diagnosis of kidney tumor was made by urographic methods and in 15 per cent more it was suggested. The correct

diagnosis was made by retrograde pyelogram in 54 per cent and by intravenous pyelogram in 31 per cent. Lung and bone metastases were found by roentgen ray in only 7 per cent of cases.

The differential diagnosis must include enlarged spleen, enlarged liver, adrenal tumor, retroperitoneal sarcoma, ovarian cyst, polycystic kidneys and hydronephrosis.

In the autopsy group metastases were found in 100 per cent of cases, the lungs being involved in 45 per cent of cases; the bones, in 36 per cent; the liver, in 27 per cent; the lymph nodes, in 45 per cent, and the renal vein in 27 per cent.

The author advises against preoperative irradiation as allowing time for metastases to develop. The only exception is in the large fixed tumor in order to make operation more feasible. In inoperable cases roentgen therapy may relieve pain and prolong life.

The author includes the classification of renal tumors proposed by Ewing. He discusses the histopathology of his group of cases. He also discusses the theories as to the origin of the hypernephroid type of tumor, giving his reasons for discrediting the Grawitz theory of adrenal rest origin in favor of an intrinsic renal origin.—*Rolfe M. Harvey.*

GRAHAM, A. P. Malignancy of the kidney; survey of 195 cases. *J. Urol.*, July, 1947, *58*, 10–21.

In a period of fourteen years 195 cases of kidney malignancy were seen at the Hines Hospital. Hematuria was the presenting symptom in 31 per cent of cases, pain was present in 24 per cent, a mass was the initial symptom in 6 per cent, and gastrointestinal symptoms were the only complaint in 8 per cent. A mass could be palpated clinically in 41 per cent. Microscopic blood was found in 20 per cent and macroscopic blood in 13 per cent; 29 per cent had significant weight loss.

Seventy-two per cent of cases had retrograde pyelograms, 66 per cent of which were diagnostic. Compression of the calices was present in 59 per cent of those with positive retrograde findings, compression of the pelvis in 22 per cent, and elongation of a calix in 13 per cent. Twelve per cent had dilatation of the pelvis, 9 per cent had displacement of the ureter or pelvis, 2 per cent had tumor calcification and 10 per cent had ureteral obstruction.

Only 16 per cent of intravenous pyelograms were diagnostic as compared to 66 per cent of retrograde studies. Of 134 cases with histologic studies 86 per cent were cortical in origin; 37 per cent had metastases on admission. Of the cases with metastases 48 per cent were to the chest and 23 per cent to the bones. Forty-one per cent were considered inoperable on first admission. One-third of the cases which were operated were found to have metastases at operation.

Lung metastases were found in 69 per cent of 80 cases coming to autopsy, 39 per cent had liver metastases, and 36 per cent had bone metastases, the spine being most frequently involved.

Thirty-five per cent had nephrectomies. Seventeen per cent survived five years. Twenty-five per cent of the operative cases had preoperative irradiation varying from 500 to 6,000 r. One-third of these had demonstrable decrease in tumor size, all of these cases having over 4,000 r. The author questions the value of preoperative roentgen therapy in view of the fact that only one-third of the cases had reduction in tumor size, operation was delayed for six weeks, and poor healing of the incisions resulted in some cases. All cases receiving palliative therapy were dead within sixteen months.

Twenty-three per cent of the total series were misdiagnosed. The primary cause for delay in diagnosis appeared to be delay in investigation of original symptoms. Sixty-one cases having hematuria did not seek medical help for an average of twenty-three months.—*Rolfe M. Harvey.*

MCLAUGHLIN, W. L., and BOWLER, J. P. The suprarenal cortical syndrome; report of a case with carcinoma of the adrenal cortex. *J. Urol.*, Oct., 1947, *58*, 221–234.

The authors define the adrenal cortical syndrome as the sum of metabolic changes produced in the body by the presence of an excessive amount of adrenal cortical steroids. This can result from hyperplasia of the adrenal cortex through the adrenotropic hormone of the pituitary or from adenoma or carcinoma of the adrenal cortex.

Steroids are organic compounds with a molecular structure similar to cholesterol and possessing biological properties giving them hormonal characteristics. The testes and ovaries also produce hormonal steroids. These steroids influence fluid and electrolyte balance, affect protein sugar and fat metabolism, pigmentation, and masculinization and feminization of the body.

The biological properties of some of the steroids of the adrenal gland are discussed, desoxycorticosterone being the only one which has been synthesized. It is now being synthesized and used in the treatment of Addison's disease. Dehydroisoandrosterone is structurally related to testosterone and has androgenic properties. Clinically the adrenal cortical syndrome may be manifested by:

(1) Changes due to excess androgens or estrogens (adrenogenital syndrome)

a. Female child toward adult masculinity.
b. Female adult toward masculinity.
c. Male child toward adult masculinity.
d. Male adult toward femininity.

(2) Changes due to excess steroids of metabolism with or without excess of androgens and estrogens (Cushing's syndrome).

Aside from the clinical picture of rapid obesity of the face, neck and abdomen, thin, easily bruised skin, hirsutism, susceptibility to infection, muscle atrophy, loss of libido, amenorrhea and psychic changes, the patients develop spinal changes which are of interest to the roentgenologist. The spine becomes osteoporotic and collapse of the bodies is common. Steroids in the urine may be detected by laboratory methods.

Adrenal tumors may occasionally be diagnosed by roentgenography. Excretory urography may show caudad displacement of the kidneys. Perinephric air injections will often outline an adrenal tumor and in some hands appears to be an entirely safe procedure. The differential diagnosis between tumor and hyperplasia of the adrenals may be difficult.

The surgical management of adrenal tumors is discussed in detail.

The authors report the case history of a white male, aged forty-four, whose admission complaint was that of low back pain. The patient had had a hemorrhoidectomy fourteen months prior to admission. This had been followed by multiple pulmonary infarcts. Nine months before admission the patient's family noticed that he was developing progressive "bloating" of the face. For the past month and a half he had complained of low back pain. The blood pressure was 140/90. Atrophy of the muscles of the arm and leg was present. Blood chemistry was negative. The basal metabolic rate was low. Roentgenograms of the spine revealed marked osteoporosis with compression fractures of the second, third, and fourth lumbar vertebrae. An excretory urogram showed questionable depression of the right kidney. Symptoms progressed following discharge and a psychosis developed. On subsequent admissions the spinal osteoporosis had increased and at this time perirenal air insufflation showed a rounded mass above the right kidney. At operation a tumor was found in this area which was histopathologically a cancer of the adrenal gland. Following operation testosterone proprionate therapy was instituted with striking improvement in all symptoms. Thirteen months after removal of the tumor spinal roentgenograms showed complete recalcification of the spine.—*Rolfe M. Harvey.*

BERRY, J. V., and BERRY, N. E. Acute exudative cystitis of undetermined etiology. *J. Urol.*, Oct., 1947, *58*, 260–267.

This condition has been described under various names such as acute exudative cystitis, acute interstitial cystitis, acute hemorrhagic cystitis, amicrobic pyuria and Reiter's disease.

It is characterized by a nonspecific urethritis followed by an acute hemorrhagic cystitis. Clinically the onset is acute with frequency, profuse hematuria and absence of loin pain or fever. In Reiter's syndrome conjunctivitis and arthritis are also present. Dilatation of the upper urinary tract also occurs in the syndrome.

The authors have encountered 24 cases, mostly in soldiers. They report in detail 3 illustrative cases, including reproductions of intravenous urograms to show the characteristic contraction of the bladder and dilatation of the upper urinary tract. The cause of the condition is unknown, although a filterable virus has been suggested. The differential diagnosis must include gonorrheal and tuberculous urethritis and prostatitis. Smears and urine cultures should aid in the exclusion of these diseases.

The roentgen findings of a contracted bladder and dilated upper urinary tract are very suggestive of the syndrome. Response to neoarsphenamines is usually rapid.—*Rolfe M. Harvey.*

VAN DUZEN, R. E. Nephroptosis producing duodenal symptoms. *J. Urol.*, Nov., 1947, *58*, 304–308.

This is a series of 3 case reports in which symptoms were present referable to the upper gastrointestinal tract, and treatment for duodenal ulcer had been instituted for varying periods of time although the true pathological

causes of the symptoms were in the genitourinary tract. All 3 cases were operated upon and found to have fibrous bands extending from the renal hilum to the duodenum and exerting traction on the latter, especially in the erect position.

All 3 cases were relieved of their gastrointestinal symptoms by operative correction of the nephroptosis and in 2 cases by division of fibrous bands extending from the kidneys to the duodenum.—*Rolfe M. Harvey.*

BURKHOLDER, T. M., and BRAUND, R. R. Massive calcinosis with chronic renal insufficiency due to polycystic kidneys. *J. Urol.*, June, 1947, *57*, 1001–1009.

The authors report the case of a forty-six year old white female whose admission complaints were of painful swellings of both shoulders, both subscapular areas, the left elbow and generalized body itching. The patient had been in good health until four years previously when she was siezed with an attack of substernal pain, nausea and vomiting and was told she had renal insufficiency due to polycystic disease. No abnormal calcium deposits were noted at that time.

Her health was good for three years after which she had recurrent bouts of hematuria, polyuria, intractable vomiting and weight loss. Four weeks before admission she noted rapid enlargement of the left shoulder with pain and itching. The right shoulder and left elbow were subsequently involved. Numerous subcutaneous masses, which appeared to be fluctuant cysts, could be palpated about the large joints. The urine contained albumin and numerous red blood cells. The blood urea nitrogen was 172 mg. per 100 cc. The serum phosphorus was 10.2 mg., the serum calcium 11.5 mg., and the alkaline phosphatase 5.4 Bodansky units.

Roentgen studies showed patchy calcification of the aorta, a large irregular dense calcification overlying the right lung and extending beyond the lateral chest wall and multiple irregular calcium deposits about the shoulder girdles, left elbow and both gluteal regions. The kidneys appeared enlarged to about three times their normal size although the pelves could not be visualized with diodrast.

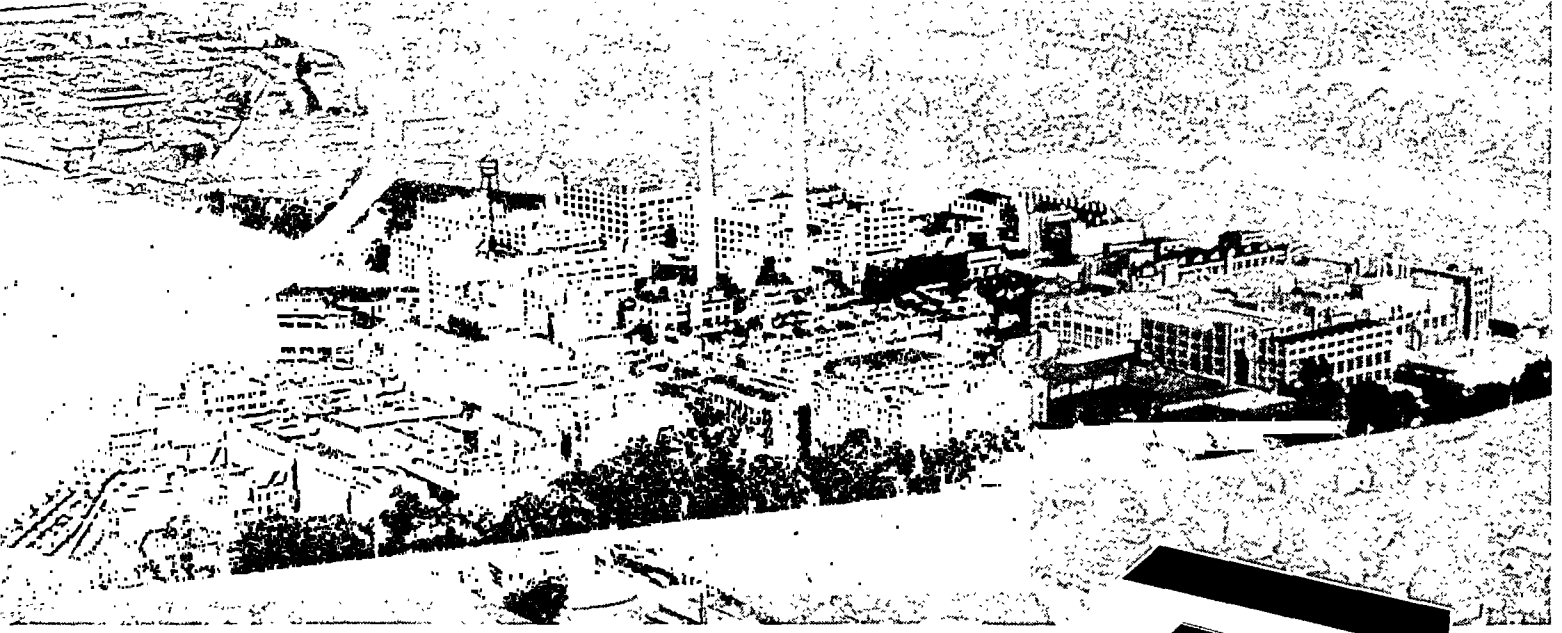
A partial excision of the mass overlying the right chest wall was done. It was a multiloculated cystic mass containing tenacious chalk-like fluid. No definite histologic diagnosis was made. The patient died in spite of therapy. An autopsy, limited to the abdomen, confirmed the presence of polycystic kidneys.

The differential diagnosis of the case in reference to calcinosis circumscripta, calcinosis universalis, myositis ossificans, metastatic calcifications, primary hyperparathyroidism and primary renal insufficiency is discussed. The authors' case is apparently one of chronic acidosis and hyperphosphatemia secondary to renal insufficiency as a result of polycystic kidney disease.—*Rolfe M. Harvey.*

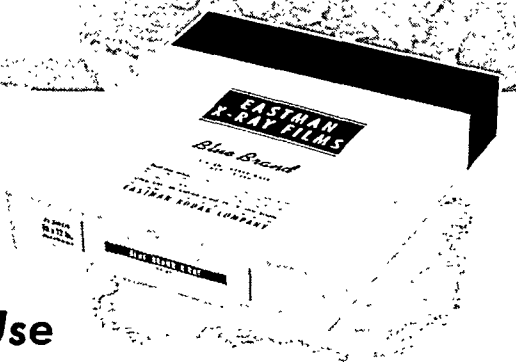
PEARSE, R., and MACMILLAN, R. L. Congenital arteriovenous aneurysm of the renal artery. *J. Urol.*, Oct., 1947, *58*, 235–238.

The authors describe the case of a sixty year old male who suddenly passed bright red blood during urination. This persisted for six days. Catheterization of the left ureter produced a few drops of very thick bloody fluid. The survey film of the abdomen was negative. A right retrograde pyelogram was also negative. A left retrograde pyelogram showed a rounded pressure defect on the middle and upper calices. The suggested diagnosis was that of polycystic kidney disease or early hypernephroma.

Four days after cystoscopy a left nephrectomy was performed and a saccular aneurysm of the renal artery, 4 cm. in diameter, was found. This communicated with a venous aneurysm which in turn caused a pressure effect on the left renal pelvis. The latter had been noted on the pyelogram.—*Rolfe M. Harvey.*



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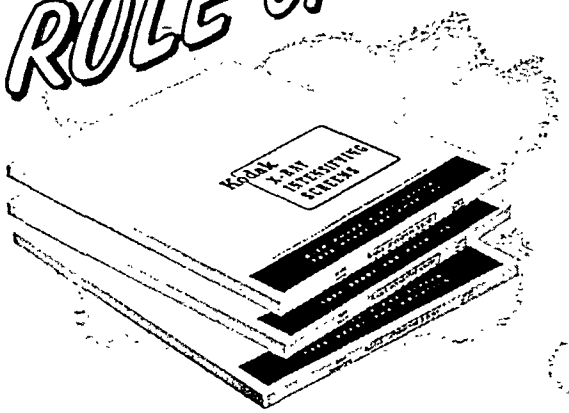
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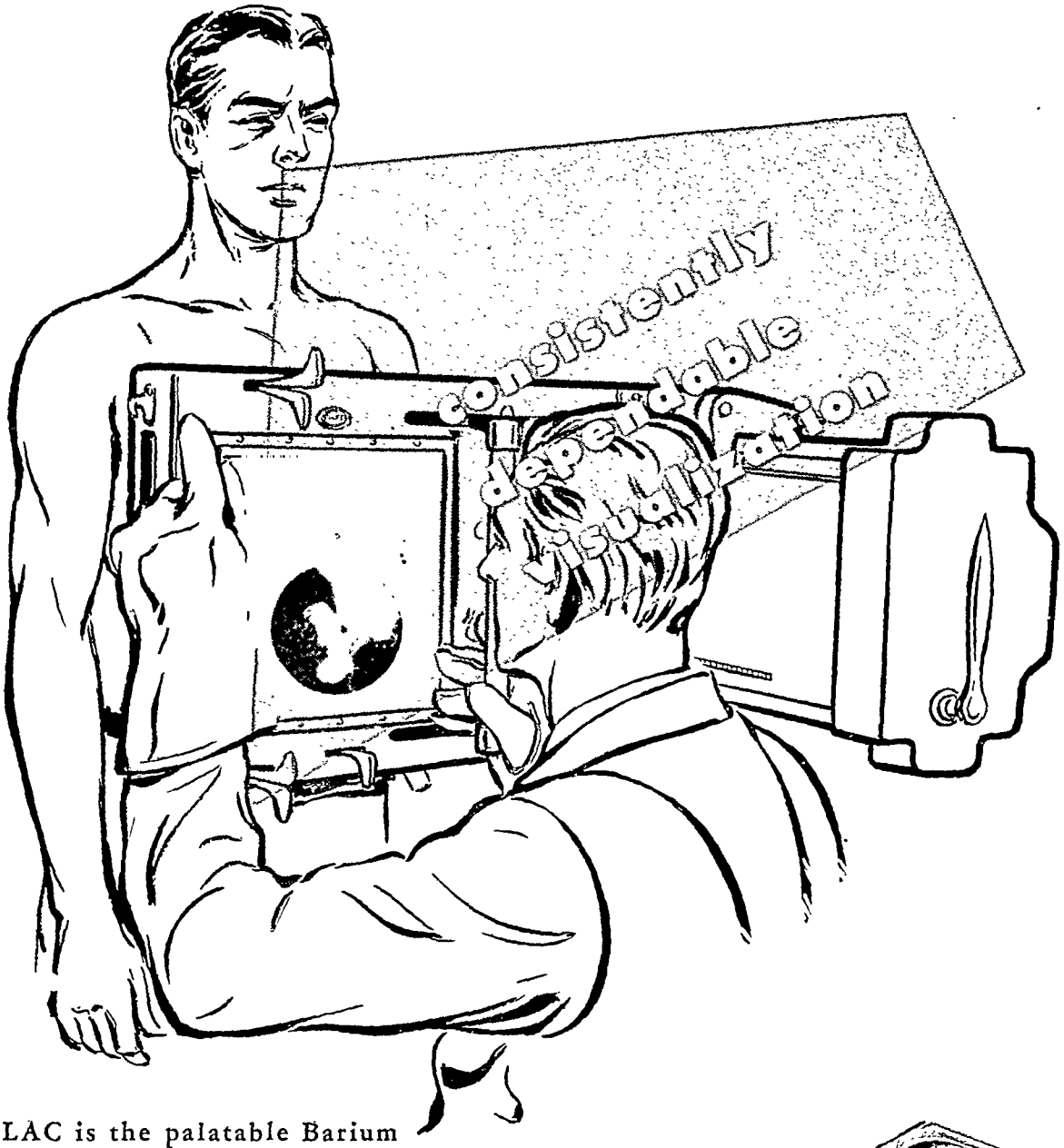
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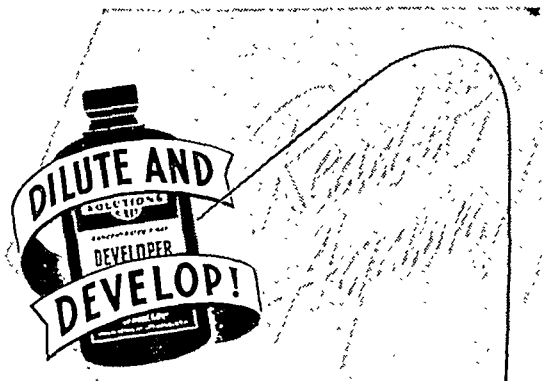
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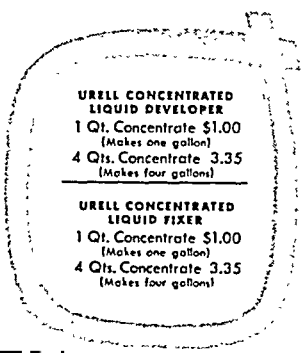
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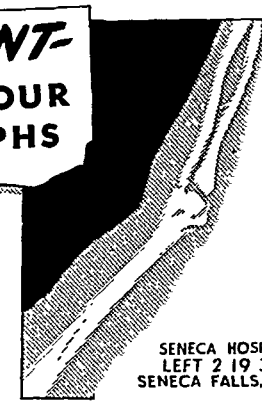
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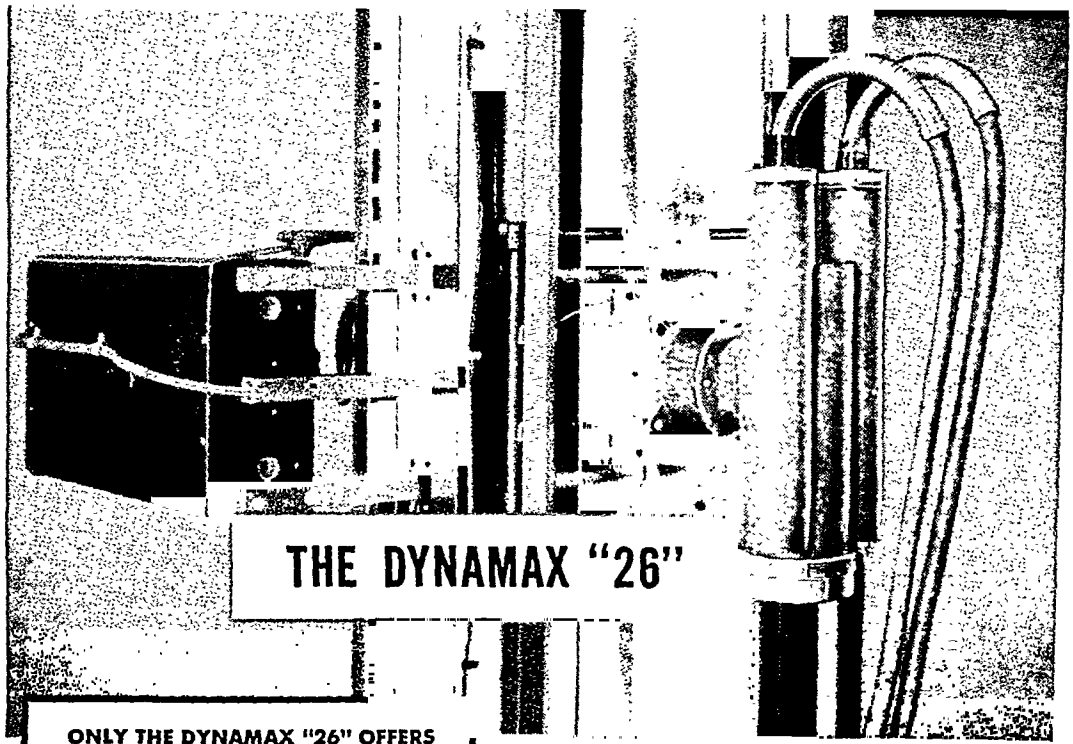
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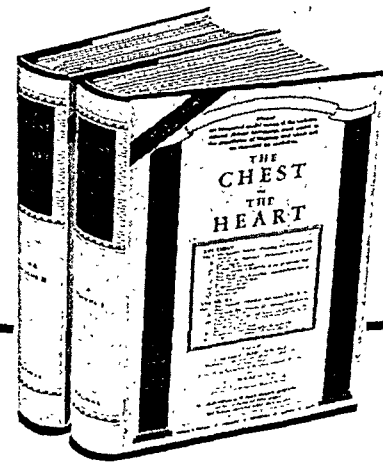
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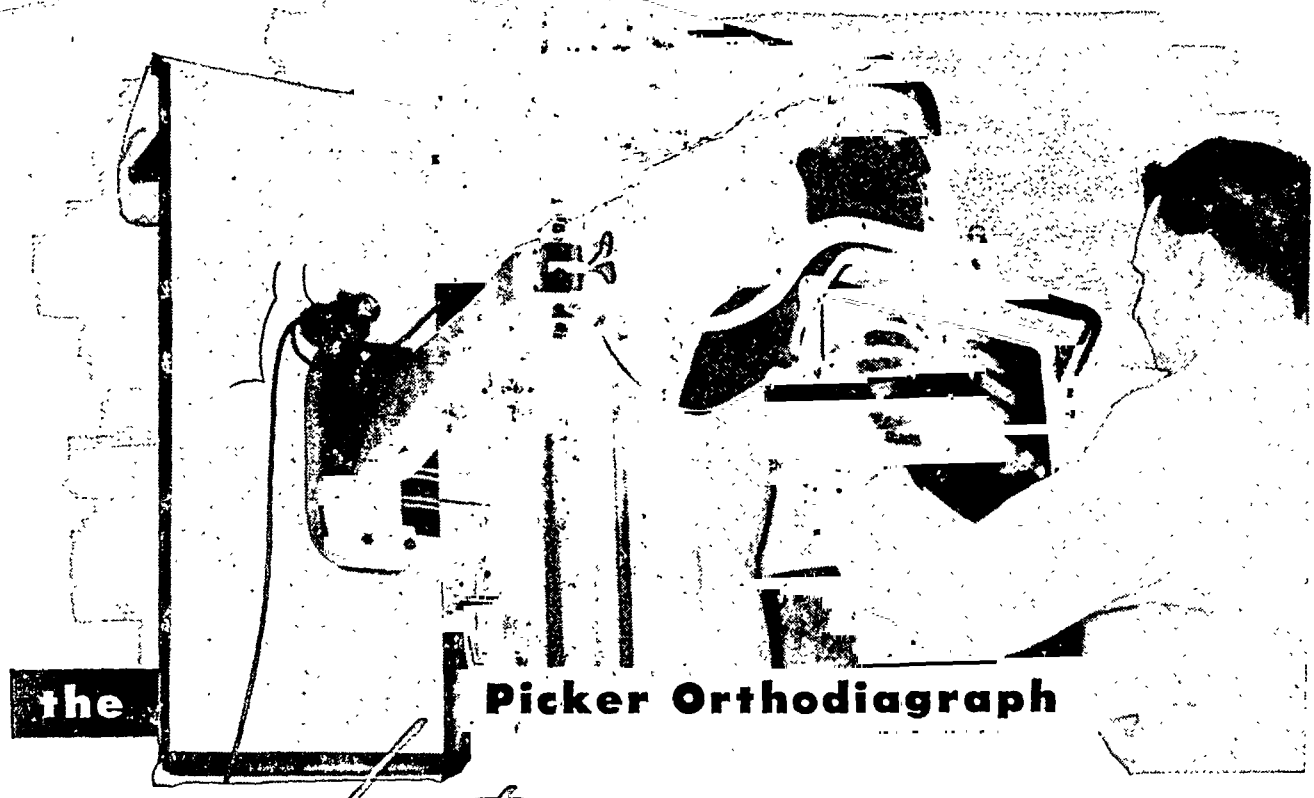
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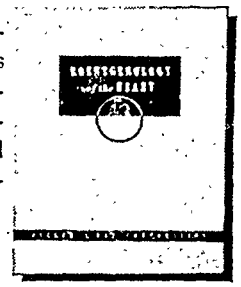
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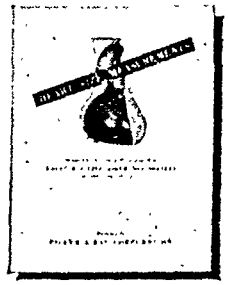
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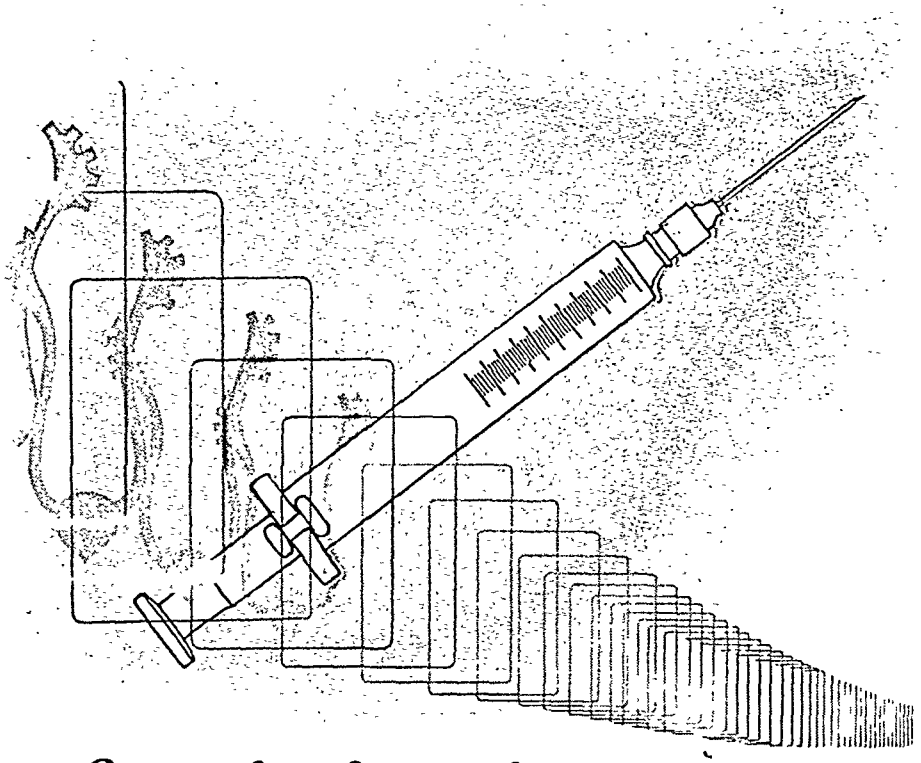
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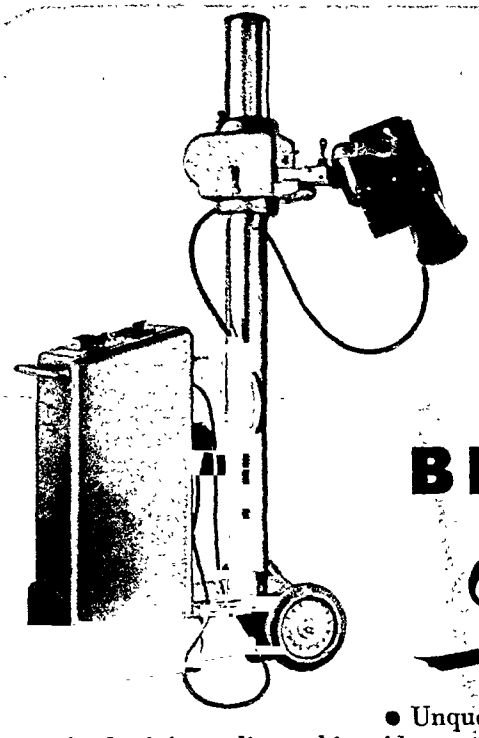
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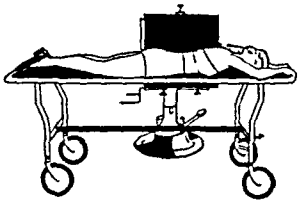
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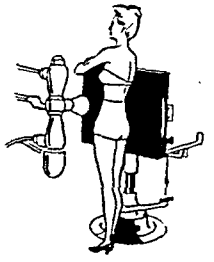
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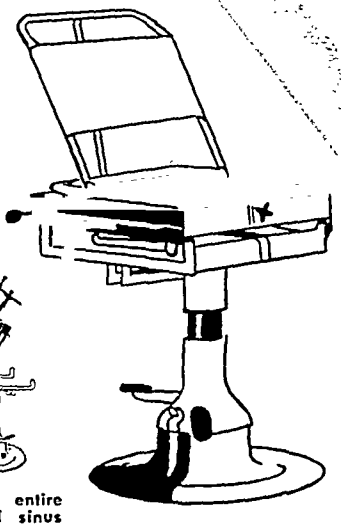
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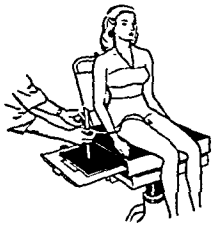
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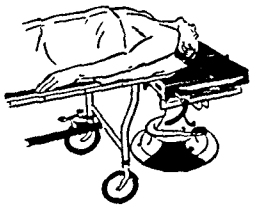
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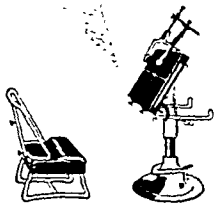




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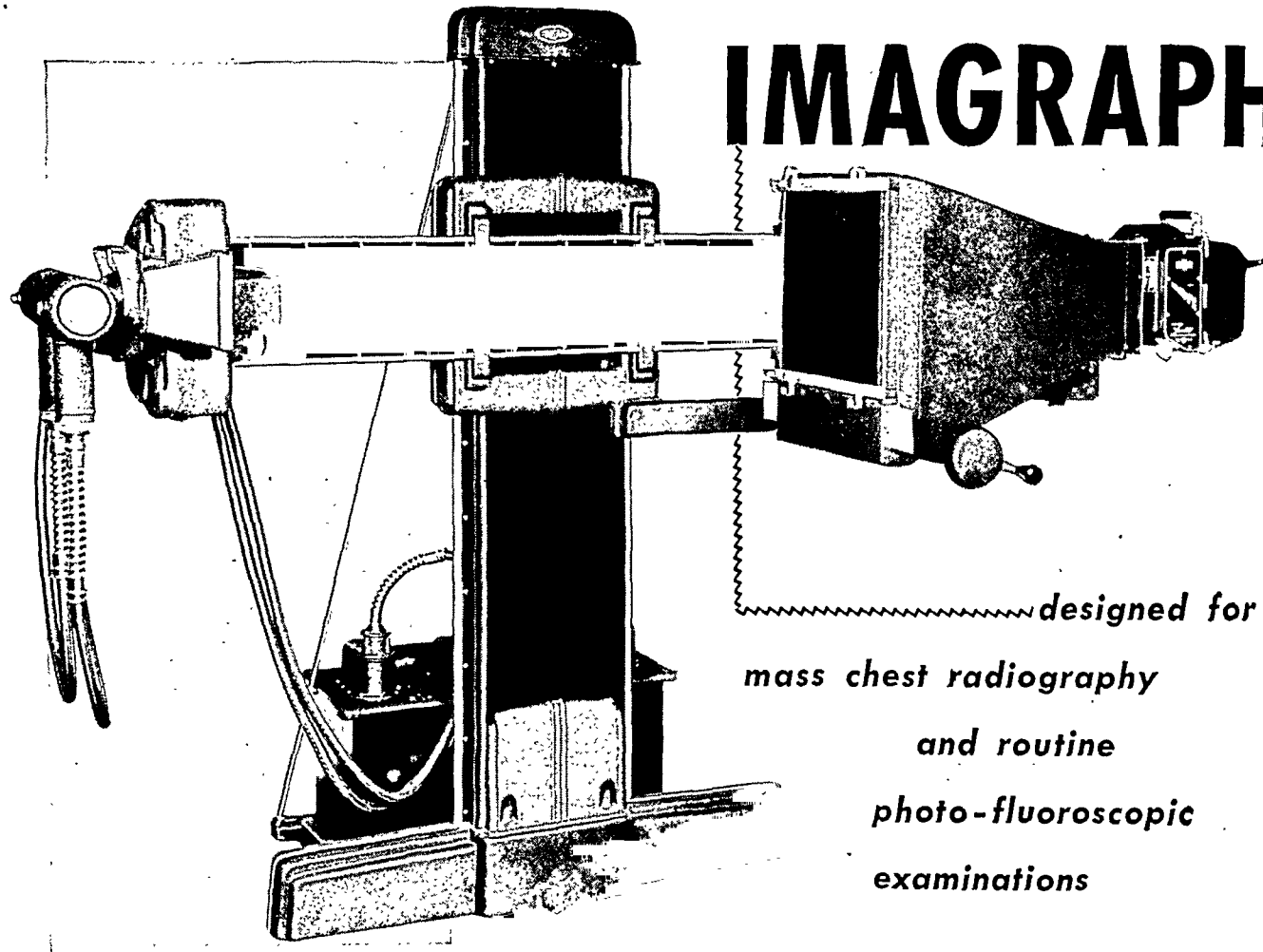
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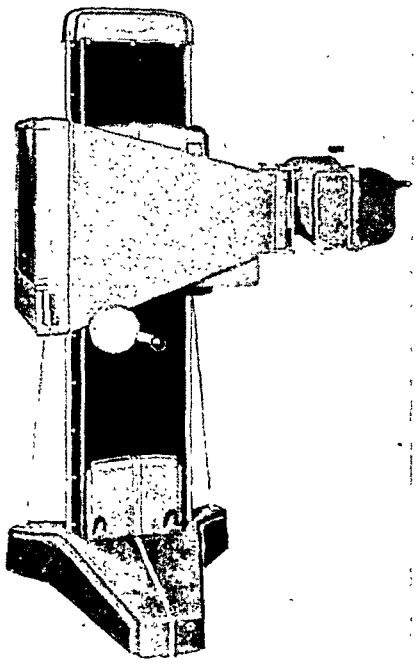
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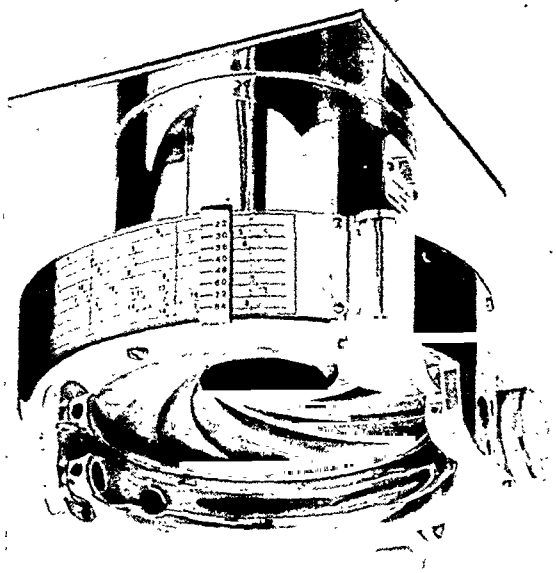
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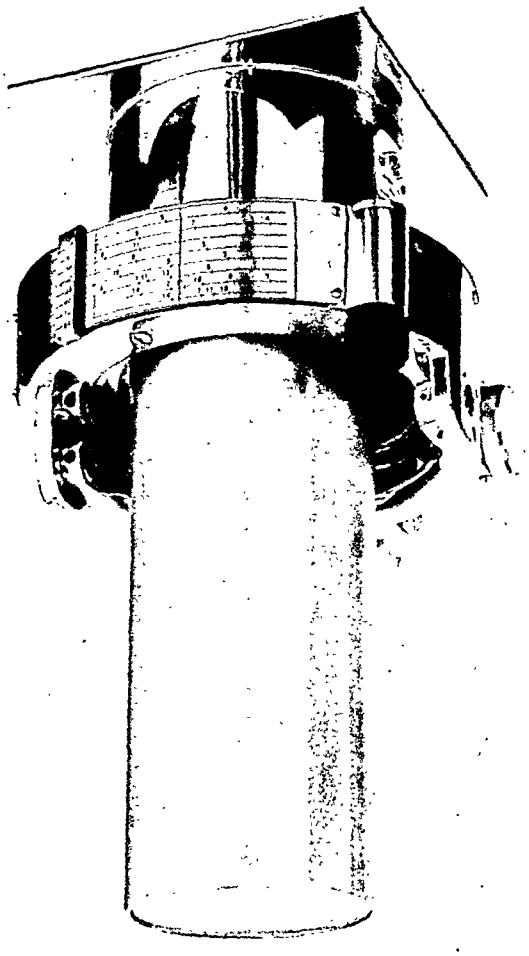
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The drying chamber of the Anhydrator is equipped with safety-interlocked doors at front and back (like a cassette "pass-box"). Thus x-ray films may be loaded wet into the Anhydrator in the darkroom and removed dry in a normally lighted viewing room.





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The surface temperature of the x-ray films in the Anhydrator will not rise above 70° F. during drying, so that the same ideal temperature maintained through temperature-controlled processing steps is preserved throughout the drying period.

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Even if the darkroom temperature is 90° or over, the same even 68° F. film surface temperature inside the drying chamber is maintained. Anhydrator drying performance is uniform winter or summer, unaffected by climatic conditions.

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During operation, no room air enters the Anhydrator; nor does moisture laden air require exhausting. The system is completely self-contained, the same air being used to absorb the moisture from the films, after which it is dried and recirculated. Anhydrator-dried films are delivered dust-free, sparkling clean.

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Because of ideal film-surface temperature during drying, the gelatin will not swell or crack due to high-temperature "cooking." Fine detail and delicate differences in radiographic film densities are fully retained by drying without heat. Film reticulation cannot result.

no film contact during drying: no abrasion

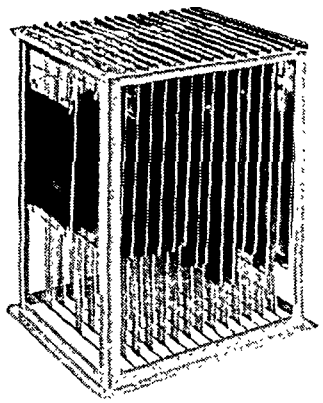
Films cannot touch each other in the special stainless steel racks. There is ample space between films for free air passage, and spacer bands prevent accidental sticking.

no ducts to build . . . simply plug it in

The Anhydrator is completely self contained. Simply place it in the most convenient location (through the wall, if desired) and plug it into any standard 110 volt AC receptacle (or DC, if specified). No architectural remodeling is required: no exhaust ducts need be provided.

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At the close of the working day, the electric timer of the Anhydrator will automatically flip a switch, and the anhydrating agent will be regenerated overnight. This same automatic control will halt reactivation in ample time to have the Anhydrator ready for service in the morning. This regeneration will take place at the pre-selected times every twenty-four hours.



The Anhydrator Film Rack

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overnight regeneration

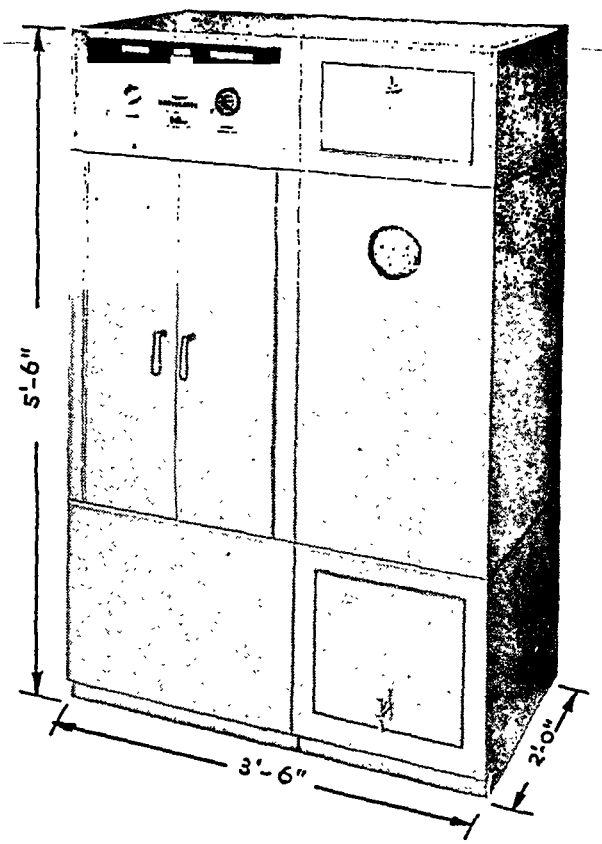
The length of regeneration time and the period chosen will depend on the quantity of films to be dried in a twenty-four hour period. The safest and most convenient cycle would be to start regeneration at the close of the working day and continue until one hour before the next day's drying is started. If smaller quantities of films are dried, this period of regeneration may be reduced (or postponed till dessicant is saturated . . . see below). It is preferred that the reactivating period be selected so that it ends approximately one hour before operations begin. Once the cycle is set on the time clock, it will automatically repeat every twenty-four hours.

saturation signal

In situations where the work load per day is not large enough to exhaust the drying capacity of the Anhydrator, regeneration is required only when the color of the dessicant (seen through the viewing port) changes gradually to red, to indicate ultimate saturation. This color change depends directly on the total square inch area of the films dried so that if traffic is light over a given period, it may not be necessary to regenerate for several days.

Drying capacity before regeneration is required

Film Size	*Total (approx.)*
5"x7"	3250
8"x10"	1425
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11"x14"	750
14"x17"	500



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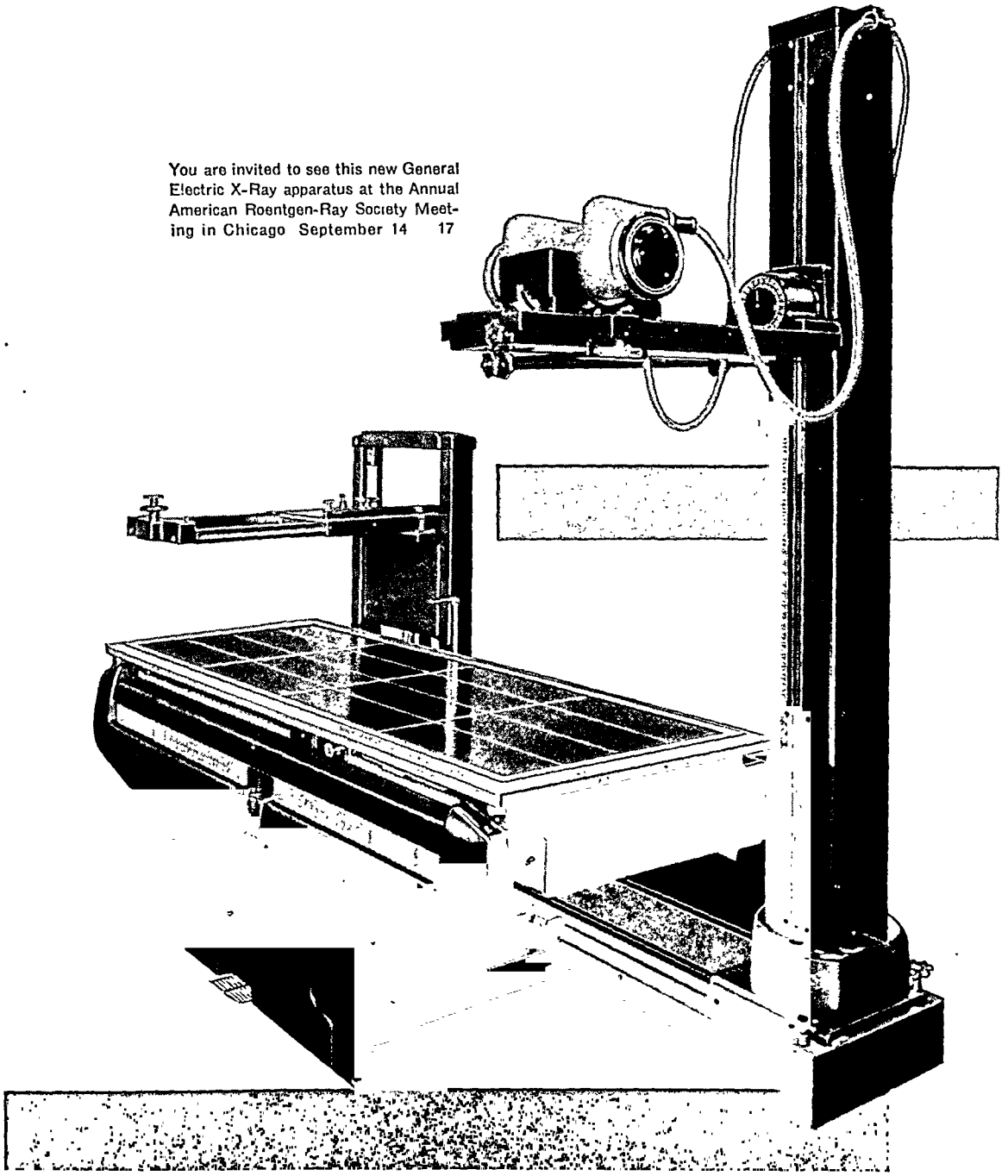
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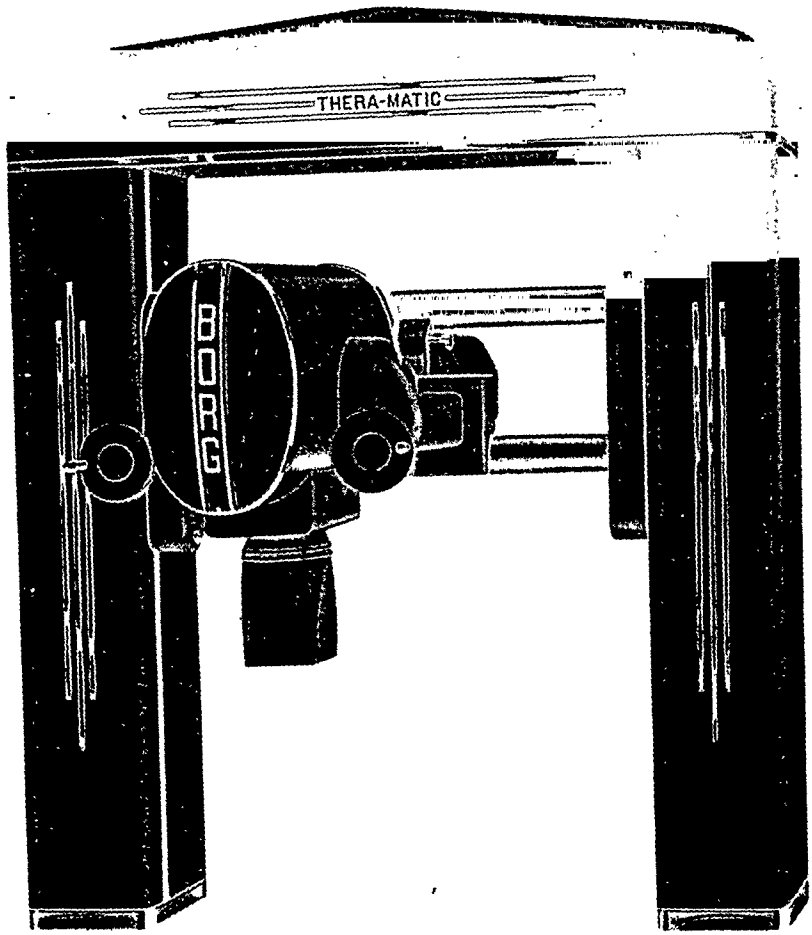
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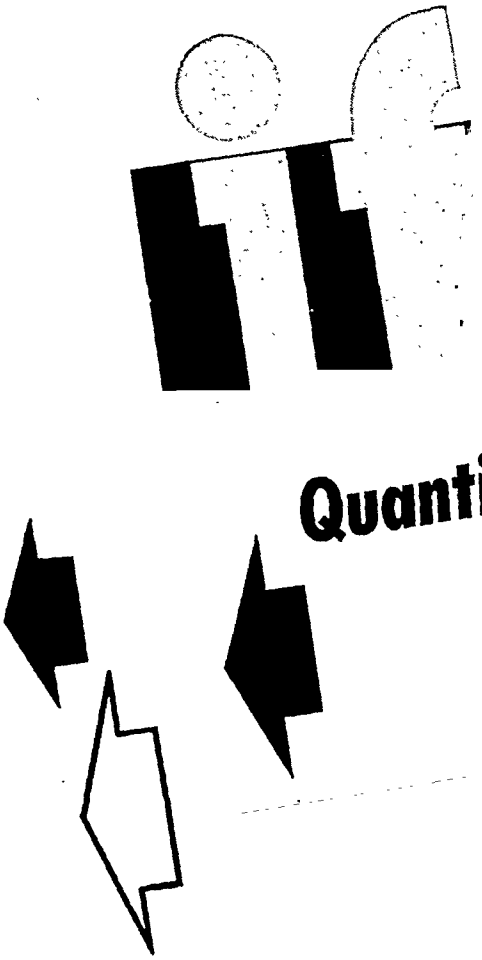
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Because of the high humidity, you need more time in summer months to dry x-ray film.

There are, however, several factors that can reduce this drying time.

The first of these factors has to do with washing. It is best, in summer months, to avoid excessive washing. For this not only speeds final drying, but excessive washing and over-long immersion may cause an emulsion to frill.

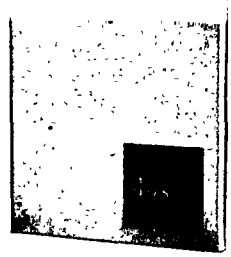
Another factor which affects drying time is the degree to which the film has been hardened in the fixer. The film should be adequately rinsed following development to prevent developer from being carried over into the fixing bath. This will extend the hardening action of the fixer. It is also important to change the fixing bath regularly.

We suggest that you consult your Ansco X-Ray Representative. He will gladly check your processing procedure and offer suggestions for obtaining best possible results.

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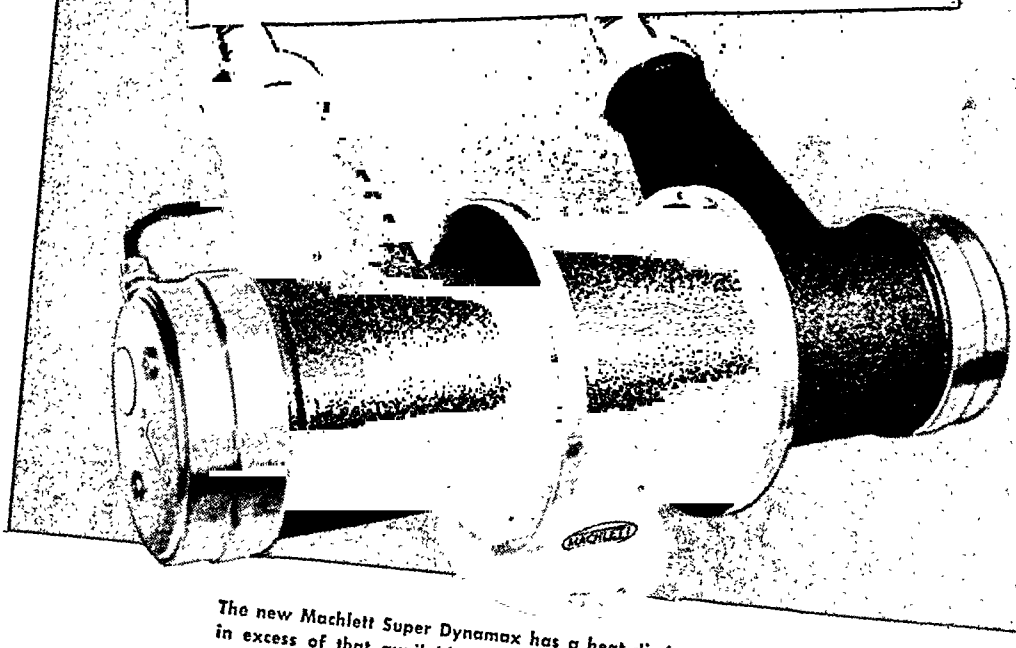
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• Recent developments in diagnostic techniques have resulted in a pronounced demand for x-ray tubes having energy ratings and heat dissipating capacities far beyond those offered by conventional stationary or rotating anode diagnostic tubes. These techniques include such new applications as high-speed photoroentgenography and cineradiography of heart action and joint movement. In order to obtain proper exposures and fine detail in rapid sequential order, fine focus and high energy loadings must be employed. These necessitated a further development of the rotating anode principle which Machlett pioneering did so much to bring to the point of practicality, reliability and economy.

To meet the new extreme demands, Machlett has developed and now offers the new Super Dynamax for the most severe modern needs in radiographic and fluoroscopic applications. With it, energies and voltages in excess of what has heretofore been considered normal can be employed. Thus, Machlett keeps pace with the newest trends in the use of x-rays for diagnostic purposes.

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Typical Example. With this remarkable new tube, it is possible to make 15 exposures per second, at 1/60th second each, 110 PKV, 400 ma., for a period of 10 seconds.

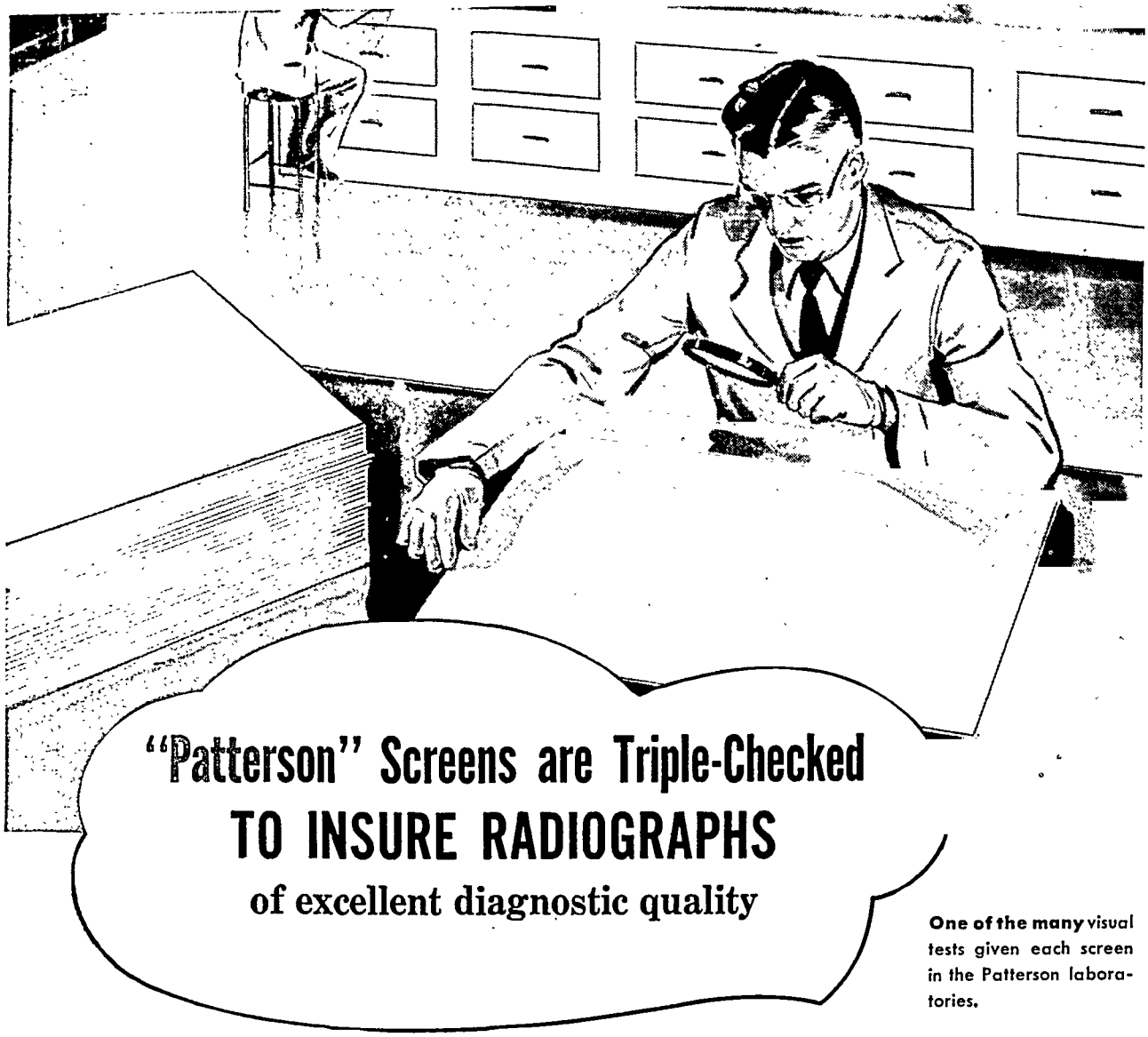
The new Super Dynamax is rayproof and shockproof and weighs only 45 pounds. It can be installed on tube carriages designed to take other modern lightweight rotating anode tubes, such as the famous Dynamax "25" and "26".

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THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

VOL. 60 AUGUST, 1948 NO. 2

TECHNIQUES FOR APPLICATION OF THE BETATRON TO MEDICAL THERAPY*

By G. D. ADAMS, G. M. ALMY, S. M. DANCOFF, A. O. HANSON, D. W. KERST, H. W. KOCH, E. F. LANZL, L. H. LANZL, J. S. LAUGHLIN, H. QUASTLER, D. E. RIESEN, C. S. ROBINSON, *and* L. S. SKAGGS

URBANA, ILLINOIS

THE high energy roentgen-ray beam of the betatron has qualities which should make it useful in the treatment of deep-seated cancers. The rays are very penetrating, and have negligible lateral ecatter; therefore, it must be possible to irradiate any region anywhere in the body with great selectivity. The elementary biological effects of high energy rays, as far as examined, have been found to compare closely with those of rays of conventional energy. Thus the introduction of the betatron into cancer therapy is largely a question of developing appropriate techniques. Some of these techniques will differ from those used with conventional equipment because of the inherent characteristics of high energy radiation.

With the 22 million volt betatron the roentgen-ray beam emerges from a focal spot less than 0.2 mm. in diameter, requires about 1.6 cm. of lead to reduce it to half intensity, and falls off rapidly in intensity with angle, reaching half-intensity at 4 or 5 degrees from the central ray (Fig. 2). Many high energy primary electrons are scattered into the room from the target, but not in the direction of the roentgen-ray beam. Penetrating secondary electrons and roentgen rays are generated as the beam passes through matter such as the tube wall and these proceed mainly in the forward direction.

Measurement and evaluation of dosage present new problems. The dosimetry of high energy roentgen rays in absolute roentgens (r), with a standard open chamber, is impractical. Tissue doses can be measured in the usual way. The readings obtained with a 25 r condenser chamber of a Victoreen dosimeter, when embedded in a suitable phantom, are used as a preliminary standard. These readings have been, in turn, calibrated with regard to conventional roentgen rays (200 kv.) by means of quantitative biological tests. At present, we multiply high energy doses by a factor of 0.75 to obtain approximate biological equivalence with rays of conventional energy.

Depth doses, in conventional radiation therapy, are expressed in percentage of the

* From the Department of Physics, University of Illinois, Urbana, Illinois. This investigation was supported in part by a research grant from the National Cancer Institute of the National Institute of Health, United States Public Health Service.

surface dose. In a beam of high energy roentgen rays, the surface is not the locus of maximum energy absorption. The surface dose is, moreover, difficult to reproduce, because of the pronounced effect of stray electrons, and it is not a very significant quantity. It is recommended, therefore, that all tissue doses be expressed in percentage of the maximum tissue dose which, in a 22 million electron volt roentgen-ray beam, is about 4 cm. below the surface. Depth dose distributions have been obtained with thimble chambers in water and presdwood phantoms. In the latter phantom, photographic films were also used. The density above fog recorded on Eastman Industrial Film Type A is directly proportional to the dose over the range of practical density measurements. Further, the constant of proportionality seems independent of position with respect to surface of the phantom and center of the beam. For our purposes, then, photographic isodensity lines have been used as isodose lines (Fig. 4, *A* and *B*).

In addition to work on dosimetry, other recent experiments on the University of Illinois 22 mev. betatron have led us to some techniques for clinical application of the betatron, which are briefly described in the following paragraphs.

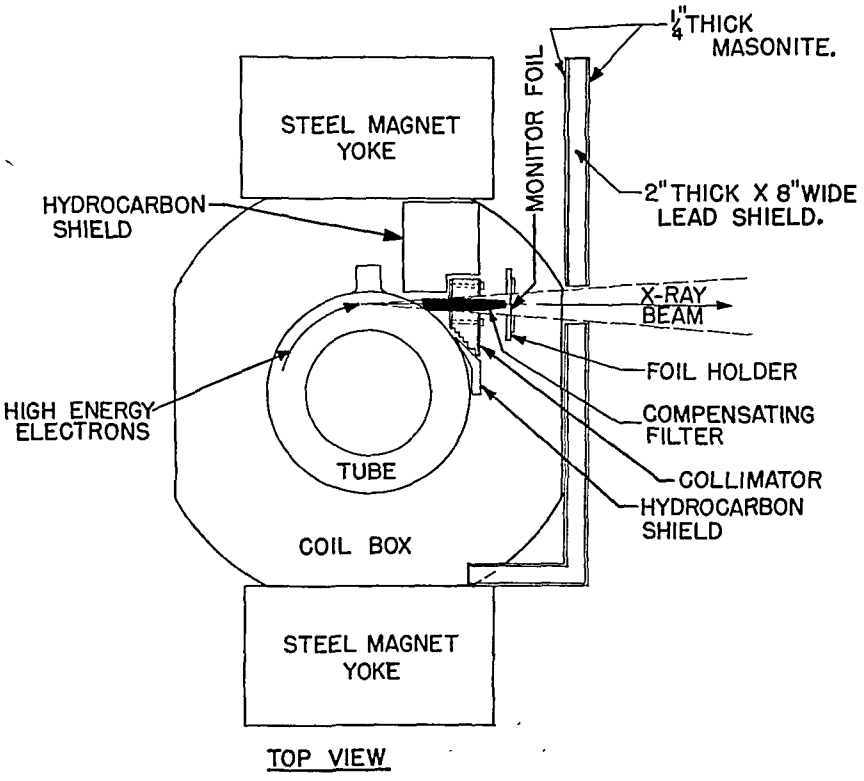


FIG. 1. Schematic top view of the 22 million volt betatron, showing arrangement of auxiliary instruments: collimator, electron and roentgen-ray shields, compensating filter, monitor foil.

Collimation of Beam. The function of the collimator is to control the size and shape of the very penetrating beam by absorbing sharply and sufficiently radiation outside of the desired cross-section. A collimator consists of lead $2\frac{1}{2}$ inches thick with a channel of desired shape. It is placed between the coil boxes of the betatron, as near the accelerating tube as possible, in order that its weight and bulk be small and that secondary electrons produced in the collimator will be deflected by the magnetic field of the betatron. The collimator is built of 1/32 inch sheets of lead alternating with insulating sheets of paper. This construction

suppresses eddy currents to a value which does not interfere with the circulating beam of electrons in the nearby accelerating tube.

The lead of the collimator transmits 6 per cent of incident roentgen-ray intensity at 20 mev., and this is further reduced to less than 1 per cent by a second solid lead shield. The disposition of collimator and outer lead shield is shown in Figure 1 and its effect in defining the beam in Figure 2.

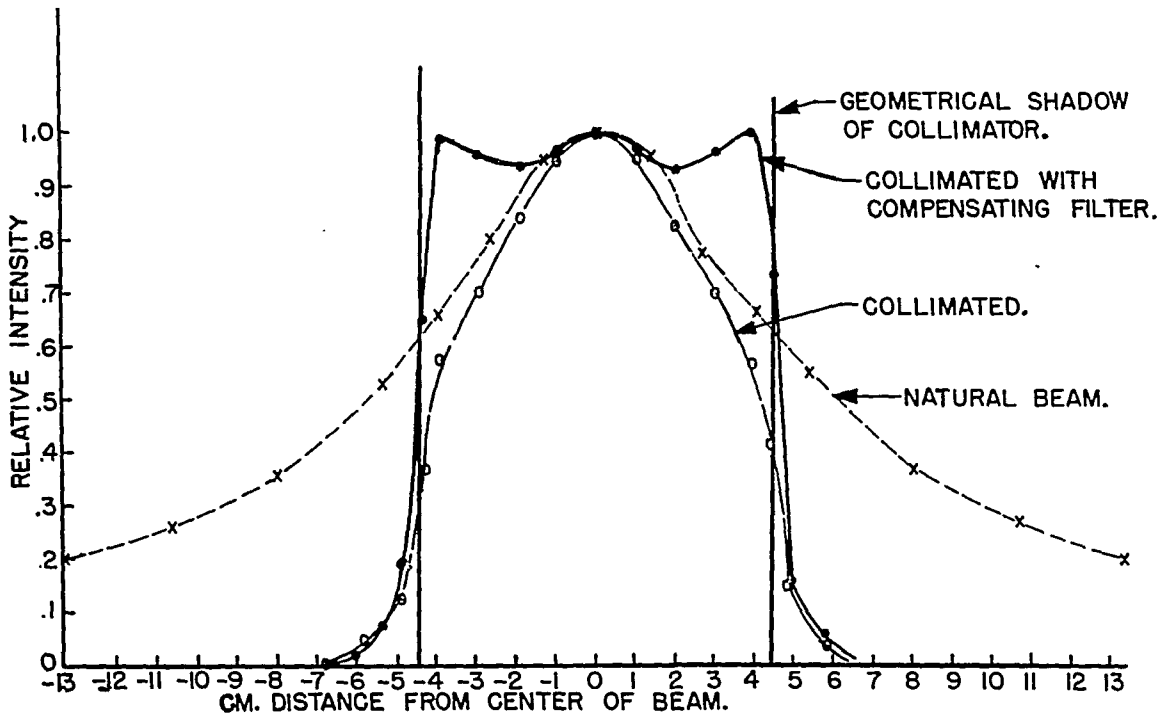


Fig. 2. Distribution of intensity across the beam. (Note: the cross section through the natural beam has been taken under conditions slightly different from those for the two collimated beams.)

Shielding of Stray Radiation. Two kinds of shields were used: (1) material of low atomic number to absorb stray electrons with relatively low production of secondary roentgen rays, and (2) material of high atomic number, such as lead, to absorb stray roentgen rays. Hydrocarbon shields placed as shown in Figure 1 absorb the electrons which are moving in curved paths but generally forward and the outer lead shield takes out the stray roentgen rays. Total ionization intensity is thereby reduced to safe levels. Typical measurements showed that at a distance of 1 foot from the primary beam, the total stray intensity was about 0.5 per cent of the beam intensity, and that at some positions in the room within 10 feet of the beam the level was less than 0.01 per cent of the beam intensity. Operating personnel, outside the room, receives less than 0.01 r even on very prolonged runs, with a beam intensity of about 50 r per minute at 1 meter.

Neutrons are produced in material near the tube target, but measurements have shown that outside the shields and under typical operating conditions, fast and slow neutron backgrounds were everywhere at a very safe level.

Compensating Filter. Filters are used to improve the characteristics of the beam in two ways: (1) by selective absorption to reduce the low energy content, and (2) by proper shaping to make the intensity distribution across the beam fit a predetermined scheme. The change in quality by selective absorption accentuates the transition rise from surface to maximum dose and increases depth doses. Both effects are small but appreciable. On the other hand,

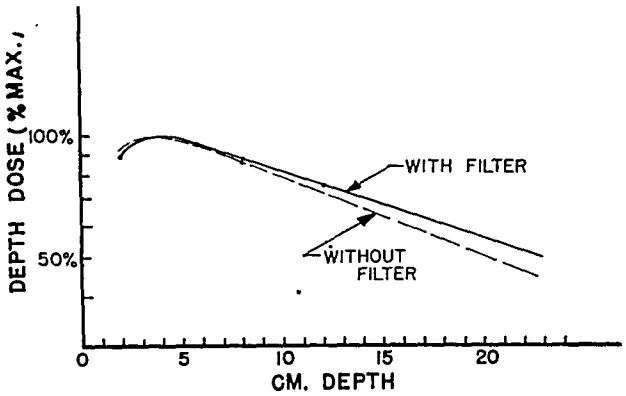


FIG. 3. Depth dose—center line. Water phantom at 100 cm. Circular beam, 11 cm. diameter. Thimble chamber measurement.

shaping the isodose surfaces is of considerable importance.

The basis for choice of filter material differs from that for conventional roentgen rays. In a continuous spectrum ranging from 0 to 20 mev., light material such as carbon transmits best at energies near the 20 mev. Hence a filter of carbon shifts the spectral distribution toward higher energy and the beam is more penetrating in tissue-like material. A heavy material such as lead has the opposite effect since it transmits best at about 3 mev. This is because of pair production which increases with energy and markedly with atomic number. A copper filter, intermediate in atomic number, leaves the quality and penetration practically unaltered, except for strong absorption below 2 or 3 mev. and would be as

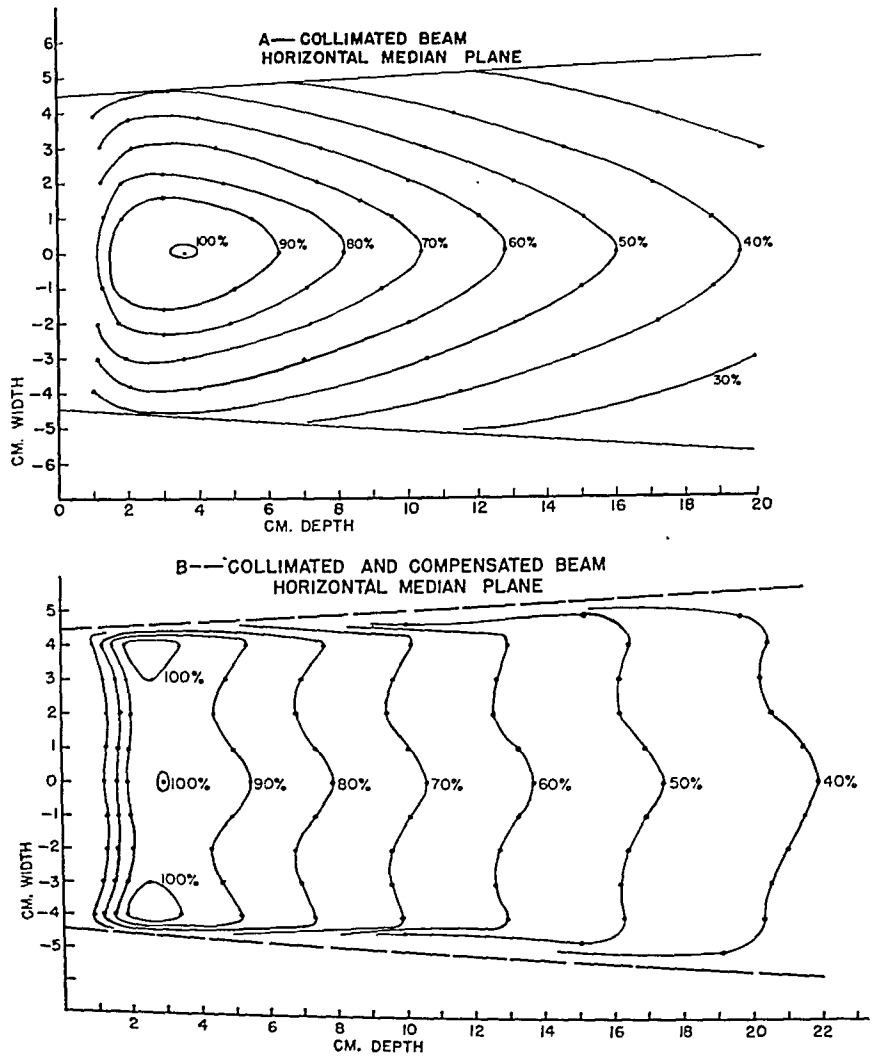


FIG. 4. Depth dose distributions. Presdwood phantom at 75 cm. Circular beam of 9 cm. diameter. Photographic measurements with thimble chamber spot checks.

suitable as carbon for shaping isodose surfaces.

Our compensating filter is a cigar-shaped block of graphite tapered so as to present less material as the beam intensity falls off from its center. It was intended to produce flat isodose levels approximately normal to the direction of the beam. It is placed in the collimator aperture and hence in the betatron magnetic field which deflects secondary electrons generated in the filter (Fig. 1).

The effects of the compensating filter on depth dose distribution are shown in Figure 3. The shape of the beam with and without filter appear in Figure 2, and the corresponding isodose levels in a presdwood phantom in Figures 4, *A* and *B*.

Monitoring of Irradiations. Monitoring of a dose administered in a given treatment involves some difficulties when the irradiated object encompasses the whole collimated beam. In such a circumstance, the most reliable solution is a transmission monitor placed between target and object. One technique of transmission monitoring uses the radioactivity induced in a thin foil. The foil is not sensitive to primary electrons, and the secondary electrons it produces are swept out by the magnetic field in which it is situated (Fig. 1). The forty minute (gamma, n) activity induced in a 0.002 inch zinc foil by irradiations of a few minutes' duration is enough to allow dosage determinations with a statistical error of less than 1 per cent. The activity of the foil is calibrated by comparison with the standard ionization chamber. However, the calibration holds only at the energy at which it was taken. During irradiation of an object the roentgen-ray output of the betatron is approximately indicated by an ionization chamber placed in the stray radiation field.

A detailed description of the techniques and devices described above will be published later in this JOURNAL.

Department of Physics
University of Illinois
Urbana, Ill.

SOME DEPTH DOSE STUDIES OF ROENTGEN RAYS FOR ENERGY LEVELS FROM 20 TO 100 MILLION ELECTRON VOLTS

By E. E. CHARLTON *and* H. E. BREED*
Research Laboratory, General Electric Company
SCHENECTADY, NEW YORK

I. INTRODUCTION

THE development of higher energy electron accelerators[2,3,14] has made it possible to investigate the depth dose of roentgen rays for energy levels much higher than the conventional voltages now generally used in therapeutics. Experimental depth dose measurements with roentgen rays up to 4 million electron volts have been reported by Trump, Moster and Cloud[12] and for energies from 5 to 20 mev by Koch, Kerst and Morrison.[4] The well known objective of radiation therapy is, of course, the destruction of malignant tissue with the minimum of injury to surrounding tissue within the volume of the body medium that the radiation must pass through. It is the purpose of this paper to present some absorption studies obtained with roentgen rays in the energy range from 20 to 100 mev, which shows the distribution of energy absorbed in a phantom at these higher energy levels, but with no evidence which would indicate or evaluate their therapeutic effectiveness as compared to lower energy roentgen rays generally used today in therapeutic treatment. The possible biological effectiveness of these very much higher roentgen-ray energies can only be adequately evaluated after careful and extensive investigations by the radiologists and the biologists working with these radiations.

II. 100 MEV ELECTRON ACCELERATOR (BETATRON)

This study was made using roentgen radiation generated by the 100 mev electron accelerator in our Laboratory.[14] The toroidal vacuum tube in this machine is made of molded Pyrex glass, and the roentgen-ray target was a tungsten rod 150 mils in diameter. The inherent filtration of the tube through which the beam emerges was $\frac{5}{8}$ inch of borosilicate glass. Since the roentgen rays coming from the tungsten target are essentially thin target radiation there was no appreciable metal filtration within the toroid for the emerging roentgen-ray beam. Roentgen rays can be generated from this machine at all energy levels up to 100 mev and most of the absorption measurements to be reported here were made in 10 mev steps in roentgen-ray voltages.

III. FILM-DENSITY METHOD OF DEPTH DOSE MEASUREMENTS

The distribution of the high voltage roentgen-ray energies absorbed in a pressboard phantom has been investigated by a film technique. From measurements of the densities obtained on different parts of a film placed within the phantom, it is possible to deduce the roentgen-ray energy absorbed by ionization in various parts of the phantom. The film used in this work was Eastman type M. The roentgen-ray voltages employed in this work were above those for which type M film characteristic data have been published. Film characteristic curves were made with 100 mev roentgen rays to compare with the published data given by the Eastman Kodak Company[11] for 200 kv. roentgen rays.

The simple relation between density and exposure may be used as a relation between density of the film and the amount of roentgen-ray energy absorbed in any area of the film. The term "density" is here

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used in the manner conventional to photographic work; that is, the density of the silver deposit produced on a film is numerically equal to the logarithm of the opacity of the film, where opacity is the ratio of light incident upon the film to light transmitted through the film. The density of the shadows on the emulsion was measured by an Ansco-Sweet densitometer which gives direct readings.

The normal range of this densitometer is from 0.00 to 3.00 in marked density steps of 0.02. One may easily read half-divisions, giving variations of 0.01. Adjustment is achieved, first by varying the brightness of the light source with a rheostat to cause the instrument to read 0.00 with no film in the aperture, second by placing a film of standard density of 3.00 in the aperture, and adjusting the instrument to read 3.00. The calibration of the instrument is further checked with standards of intermediate density. The range of the instrument for some measurements was extended to a density of 3.60 by using a stronger light source and a larger aperture.

The densitometer was found to repeat density measurements of given films with an error of less than 1 per cent. The area of the film measured is 0.079 cm.^{2} The ability to measure such a small area, to measure continuously over all parts of the film, and to measure film exposed very close to the phantom surface are advantages of the photographic method of phantom operation.

The relative ionization was measured with the standard Victoreen r thimble and meter. The least error in reading the 25 r scale is about $\pm$0.1 r for which the scale is marked every 0.5 r. Many measurements in making the film characteristic curve were between 5 and 10 r, so the relative error introduced is probably about 2 per cent. It should be noted that in comparing films or points on a film, this error does not enter the measurement.

To determine the necessary relation between ionization and density the following procedure was used: If the film and thimble are exposed to the same part of the roentgen-ray beam simultaneously the presence of one will affect the response of the other, due to scattered and secondary radiation. Simultaneous exposure is not necessary, for a relation between two variables may be established in terms of the dependence of each of these variables upon some third variable. This was accomplished by alternately exposing film and standard thimble under identical conditions while an ionization chamber monitor was kept in a fixed position to one side. Thus a relationship between film density and relative ionization is established. The film was exposed in a cassette made of two pieces of lead, each $\frac{1}{4}$ inch thick. The r thimbles were also jacketed in lead $\frac{1}{4}$ inch thick. This thickness was chosen because at 100 mev it gives nearly maximum intensification. To obviate any question of the non-dependence of the film characteristic curve upon the absorbing material, this step was later done in a pressboard phantom by exposing five films for different periods of time and subsequently developing them simultaneously. The film and thimble were alternated in pressboard at a depth of 9 cm in the phantom while the monitor was kept in a fixed position. The films were developed at 68° F. for eight minutes. Then the films were rinsed in a shortstop for one minute, and then fixed. The developing time of eight minutes was chosen as standard procedure in this study for two reasons. First, eight minutes' development gives high contrast without unduly high fog level, and second, the slope of the time-gamma curve is not as steep at eight minutes as it is for shorter times, so the relative errors in density introduced by inequalities in development would be minimized. Development longer than eight minutes gave higher fog level and densities above the usable range of the densitometer.

The film characteristic curves for 100 mev radiation and for 200 kv. radiation with Eastman Kodak type M roentgen film are shown in Figure 1. The values obtained in lead and in pressboard for 100 mev radi-

ation fell on the same curve A, within the experimental error. On the same plot the Eastman Kodak Co. data shown on curve B for 200 kv. radiation falls practically on the same line. This justifies the assumption that the relation indicated in curve A between film density and relative ionization holds for all energy levels between 20 and 100 mev.

A correction for variations in fog level

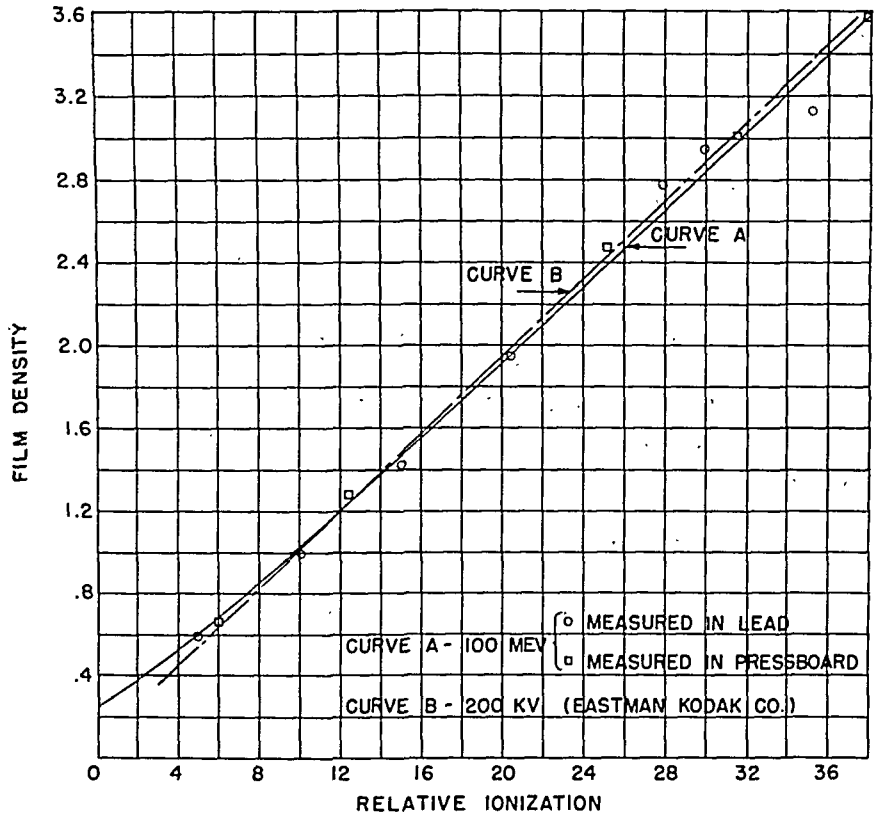


FIG. 1. Film characteristic curve.

density due to age, etc., must be made. The value of fog level experienced when making the film characteristic curve was 0.24. This was arbitrarily assigned to be the normal value, and corrections were made for variations from this value.

The Phantom. The phantom used in this study (Fig. 2) consists of a "U"-shaped wooden clamp which holds 56 sheets of pressboard (Masonite tempered board), the dimensions of each being 14 by 17 by $\frac{1}{4}$ inch. The scale shown in the photograph is in inches. The clamp is built of hard wood with no metal parts, the joints and fastenings being made with glue and wooden dowels. The pressboard was found to have a density of 1.083 ± 0.005 gm/cm^3. The mass of various pieces of the same area differed, but micrometer measurements showed a corresponding variation in thickness. Film cassettes were made by placing the film between two sheets of pressboard and binding all the way around with opaque scotch tape. A film cassette made of two sheets of pressboard bound with white tape is shown in the center of the phantom. The phantom may be arranged in any desired position relative to the betatron. The minimum working distance between roentgen-ray target and front plane of phantom, limited largely by the dimensions of the 100 mev betatron itself, is 125 cm.

Films were exposed in the phantom in two distinct positions. In one, the film was placed so that its long dimension lay along the axis of the roentgen-ray beam, giving an "axial" exposure. Thus one end of the film was at zero depth in the phantom and the other end at 43.2 cm. depth. In this

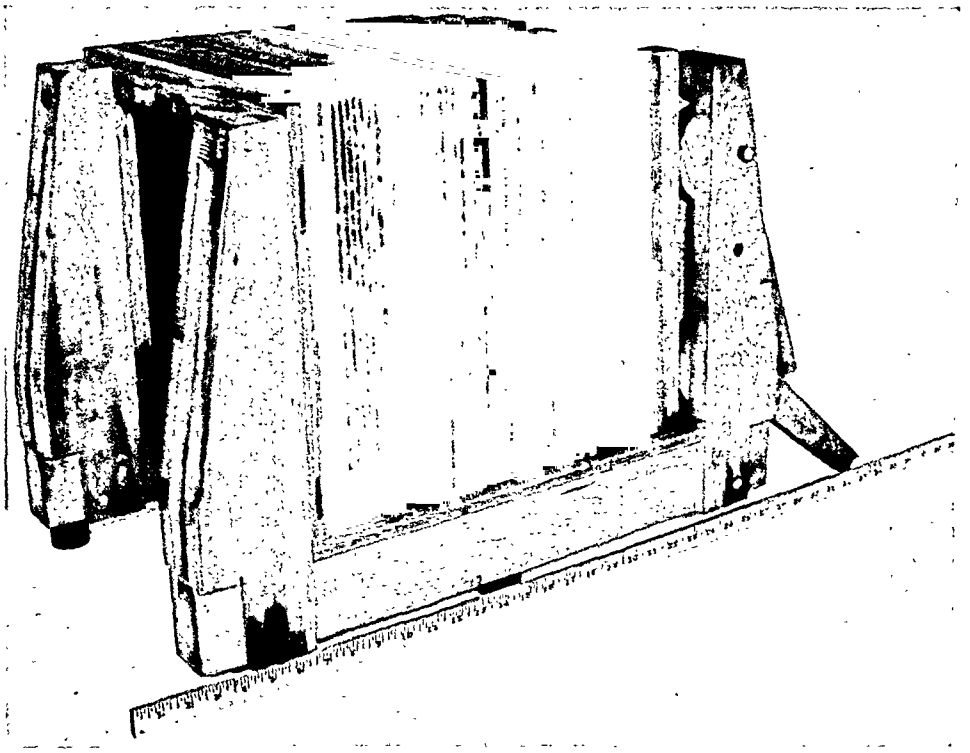


Fig. 2. The pressboard phantom.

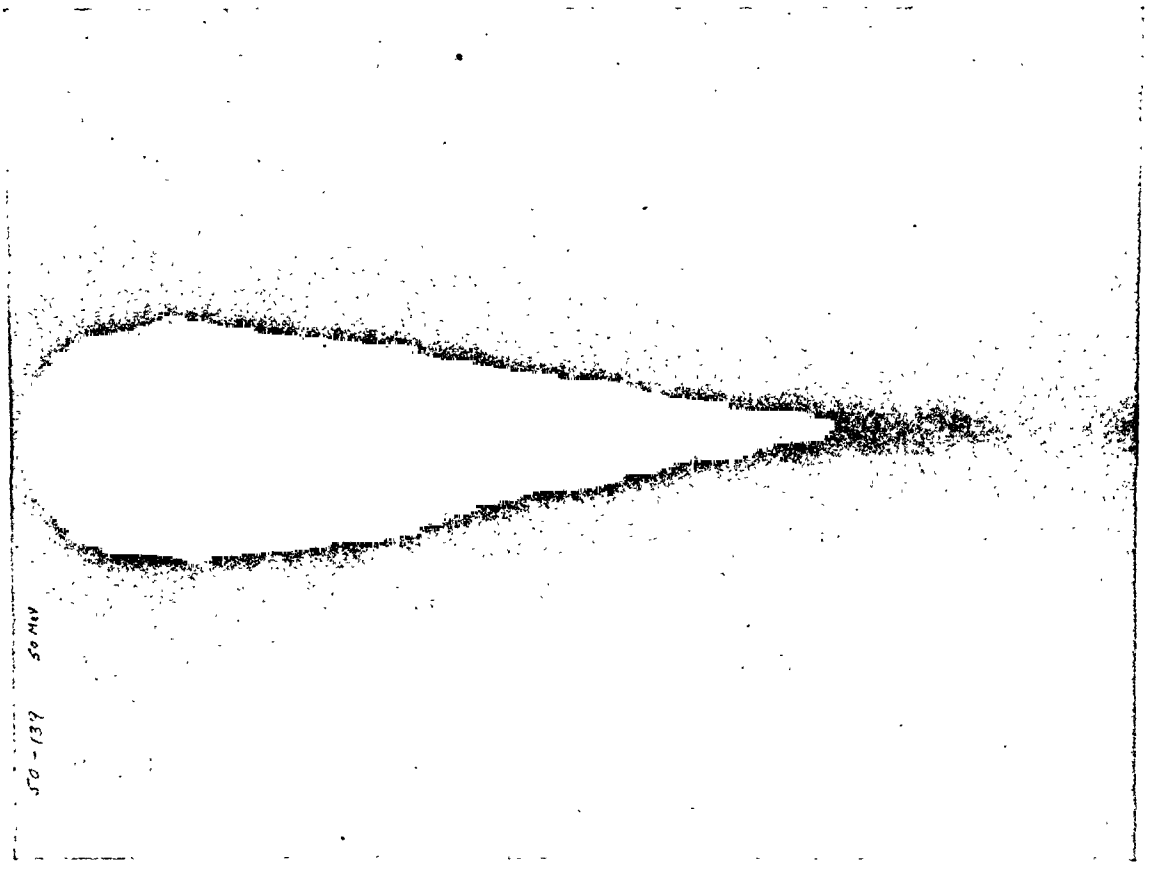


Fig. 3. Photograph of 50 mev roentgen-ray beam in phantom.

case the phantom was placed so as to be symmetrical with the axis of the beam. A film so exposed shows density as a function of depth and at right angles from the axis at the same time. The second method is to expose the film so that the axis of the beam is perpendicular or "orthogonal" to the center of the film, as in taking a common roentgenogram. These orthogonal films show the cross-section distribution of the beam for different depths and distance from the target. It was useful to expose several orthogonal films simultaneously, one behind the other at different depths. The orthogonal films provided the best methods of evaluating the "skin dose". For the film placed on the source side of the phantom a cassette is made of a piece of opaque celluloid 0.16 mm. thick and a piece of pressboard bound at the edges. Thus a film may be placed in the phantom from a depth of 0.16 mm. in organic material up to 35 cm. in steps of 0.63 cm. In all cases, the films were developed by the procedure previously described. Films exposed simultaneously were developed simultaneously.

Since the ionization produced in a given volume of air is a small fraction of that produced in an equal volume of pressboard, care must be exercised to reduce the air voids between the pressboard sheets in the phantom to a minimum. This is accomplished by applying the clamping mechanism uniformly.

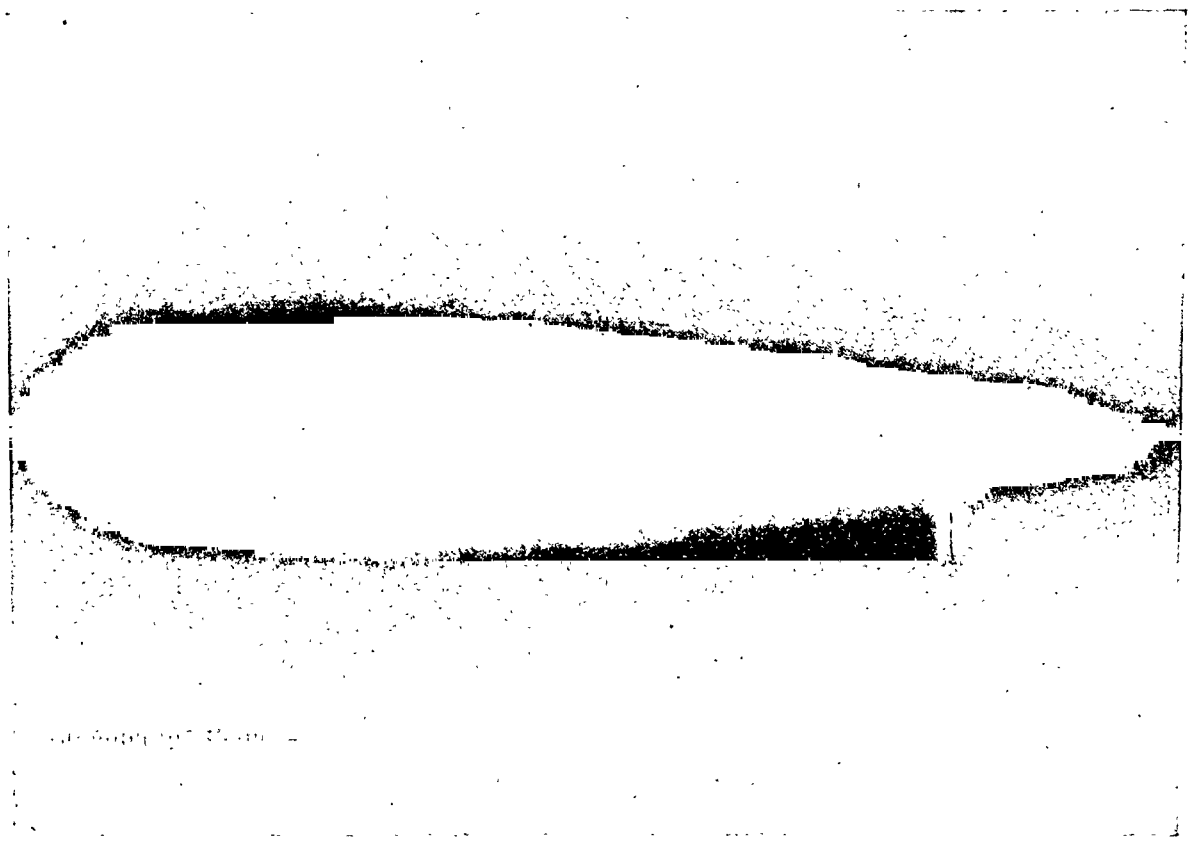


Fig. 4. Photograph of 100 mev roentgen-ray beam in phantom.

Figures 3 and 4 show photographs of the roentgen-ray beam taken on axial films in the phantom at roentgen-ray voltages of 50 and 100 mev. These are 14 by 17 inch films. These films were made in the phantom at 132 cm. target distance. No collimation or filtration of the betatron beam was used in taking these photographs. The beam with the 100 mev radiation is inherently more collimated and more penetrat-

ing than the 50 mev radiation.

Isodose Charts. The isodose curves shown here (isodose charts for 50, 70, and 100 mev) (Fig. 5, 6, 7) have been made by densitometering the axial phantom films. For comparison on a percentage basis the film density readings have been converted to relative ionization by using the data obtained in Figure 1. Then the peak value is considered 100 per cent, and lower ionizations are expressed in percentages of the peak value.

Densitometer readings of several axial films made at the same roentgen-ray voltage give good agreement in the values shown in these isodose charts. Axial films have been exposed with the plane of the film both horizontal and vertical. Analysis of these has shown the distribution of density along and across the axis to be in good agreement. A three dimensional concept of the absorption pattern may be had by rotating an axial isodose chart about the axis.

The isodose charts illustrate the same trends that have already been pointed out in discussion of the photographs; namely, at higher roentgen-ray voltage the peak of ionization occurs at a greater depth, and the angular width enclosing 50 per cent of the roentgen-ray beam is less.

Figure 8 shows the relative ionization along the axis of the roentgen-ray beam as a function of depth at different energy levels. These data for each energy level were plotted from orthogonal exposures for which twelve films were placed at different depths in the phantom and the whole family of films were exposed and processed simultaneously. The point of maximum density on each of the twelve films was located and measured with the densitom-

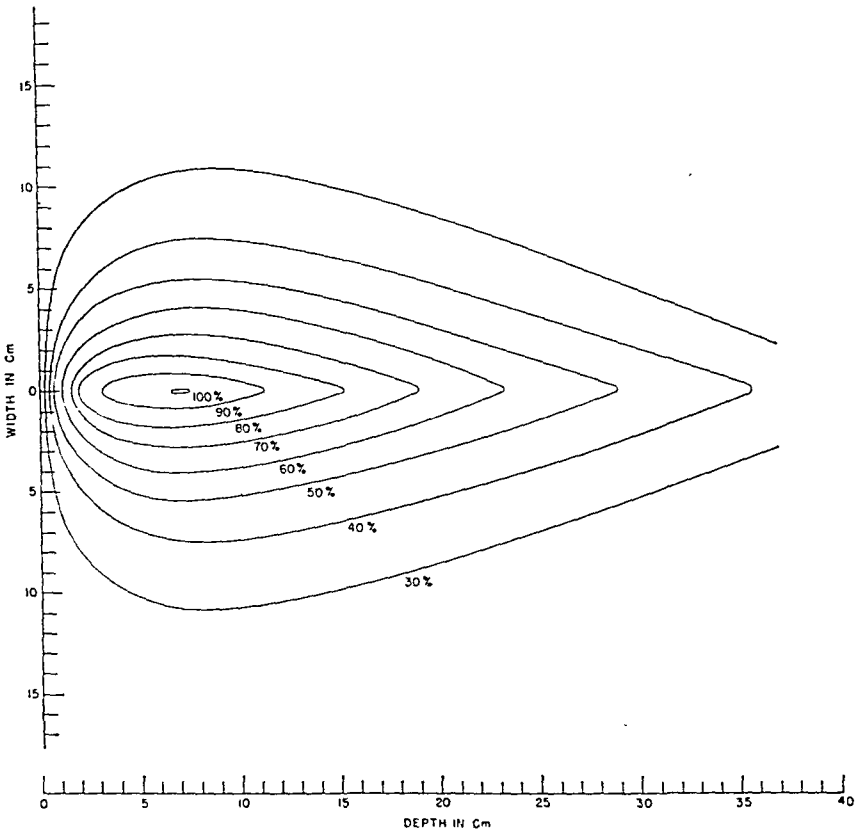


Fig. 5. 50 mev isodose chart. This map was made from an axial film exposed at 132 cm. target-phantom distance with no limiting aperture.

eter and the corresponding relative ionization factor obtained from Figure 1. Unexposed films were developed with each group and measured to obtain the correction factors for any variation in fog level. All of the values of relative ionization for each energy level were multiplied by the logarithmic plot made from data obtained from Figure 8 gives a linear relation within experimental error between the relative peak ionization and the depth of the peak for the different roentgen-ray voltages.

The depth dose measurements presented in Figure 8 are in reasonable agreement

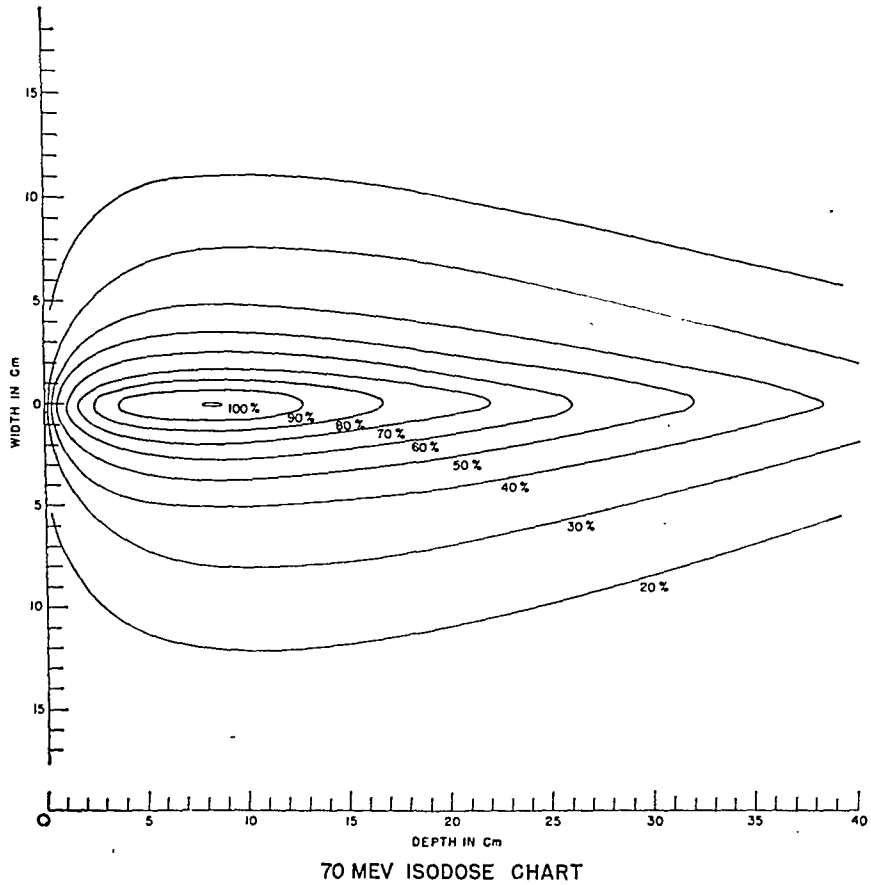


FIG. 6. 70 mev isodose chart. This map was made from an axial film exposed at 132 cm. target-phantom distance with no limiting aperture.

reciprocal of the relative ionization value of the first film taken at 0.016 cm. depth, in order to bring the relative ionization for the approximate entrance point in every case to unity. This permits one to compare relative ionization in depth for different roentgen-ray voltages in terms of unit absorption at an entrance depth of 0.016 cm. It is readily seen that with increasing voltages the peak value of ionization not only occurs at a greater depth but when the entrance dose is held constant these peak values are greater.

It is interesting to note that a semi- with similar measurements in a pressboard phantom with the 100 mev betatron made by Failla, Braestrup, Klaiber and Charlton (Fig. 9) in which they used an ionization chamber method in place of the film-densitometer technique. The ionization chamber method used has been described by Failla.[1] The target-phantom distance in this case was 116 cm. The dotted curves in Figure 9 for energies up to 20 mev are from data reported by Koch, Kerst and Morrison.[4]

The peak absorption for 50 mev comes at a slightly lower depth for the ionization

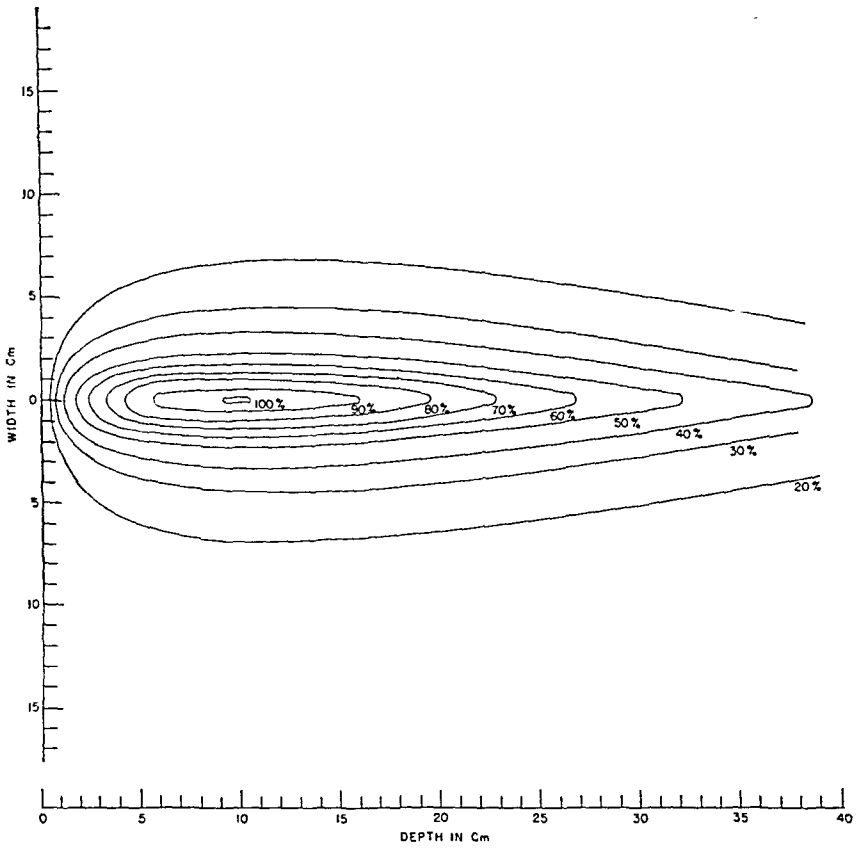


Fig. 7. 100 mev isodose chart. This map was made from an axial film exposed at 132 cm. target-phantom distance with no limiting aperture.

method than that obtained for the film densitometer technique. This was apparently due to the fact that in the ionization chamber measurements, the pressboard phantom was closer to the target; this effect will be discussed below. No collimation nor filtration of the beam was used in these experiments to filter out the electrons. The differences in peak ionization values between Figures 8 and 9 at different roentgen-ray voltages are dependent upon the arbitrary depth in the phantom chosen as the reference point for unit absorption.

In Figure 10, plotted to give the same peak ionization for different roentgen-ray voltages, it is apparent that while the entrance dose is decreasing with rising energy levels, the exit dose is increasing. One can readily see that a given percentage of peak energy is absorbed at different depths for different voltage levels. These data were obtained with a target-phantom distance of

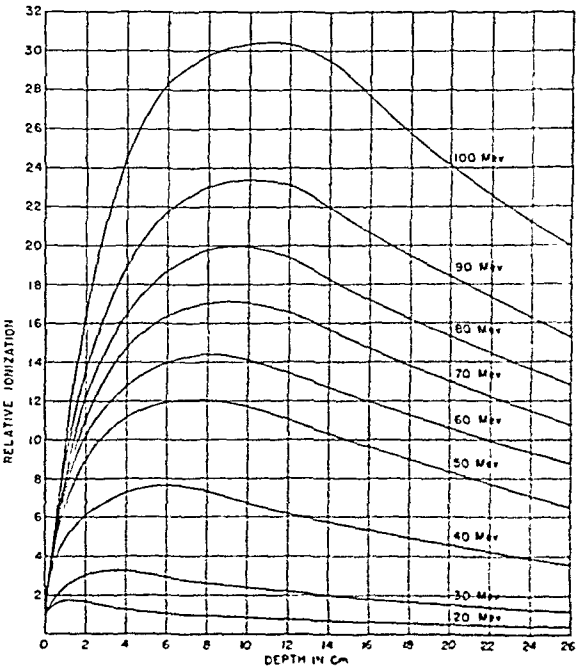


Fig. 8. The relative ionization at any depth in the phantom caused by a unit entrance dose, at energy levels from 20 to 100 mev.

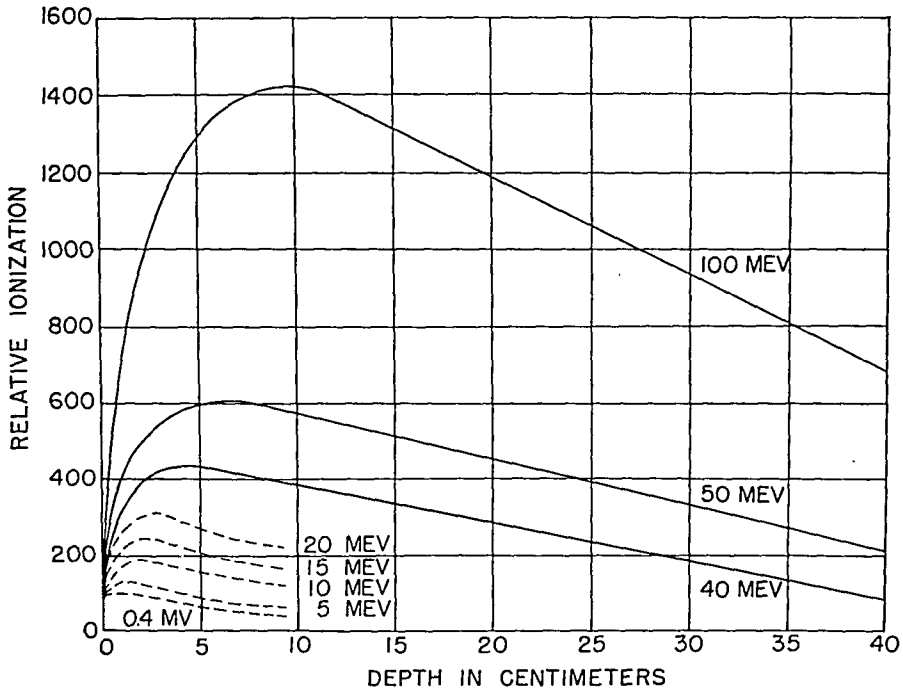


Fig. 9. Ionization chamber method of depth dose measurement in pressboard phantom using high energy roentgen rays from betatron.

132 cm. If this distance is decreased, more attentuation due to inverse square effect will be experienced, the depth of the peak will decrease and the exit dose will decrease. The converse will occur at greater target-phantom distance. Were it not for variations in intensity across the field of the roentgen-ray beam in the relatively small angles enclosing 50 per cent of the total intensity, it would be desirable to use the

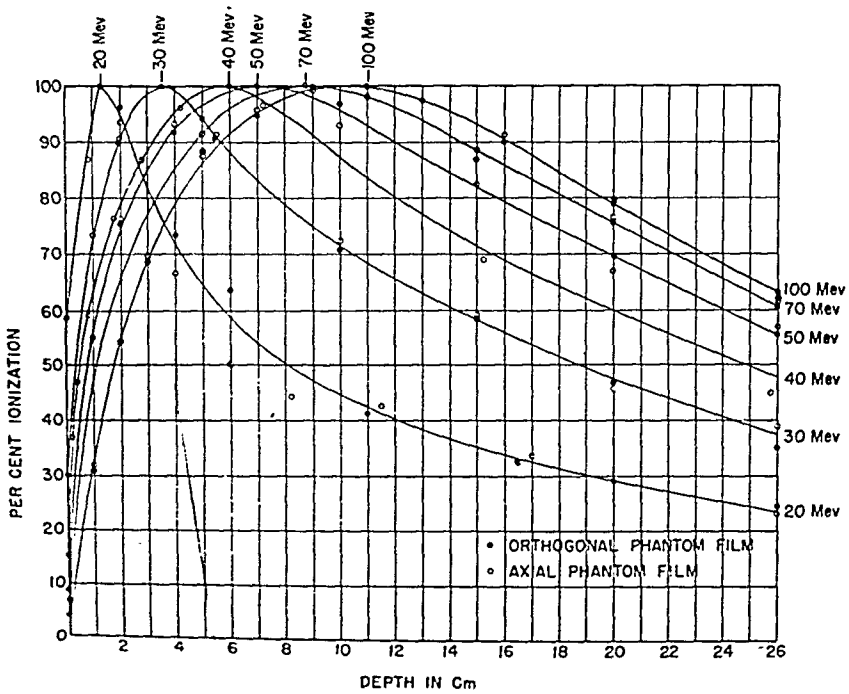


Fig. 10. The per cent of peak ionization occurring at any depth in the phantom for the various roentgen-ray voltages.

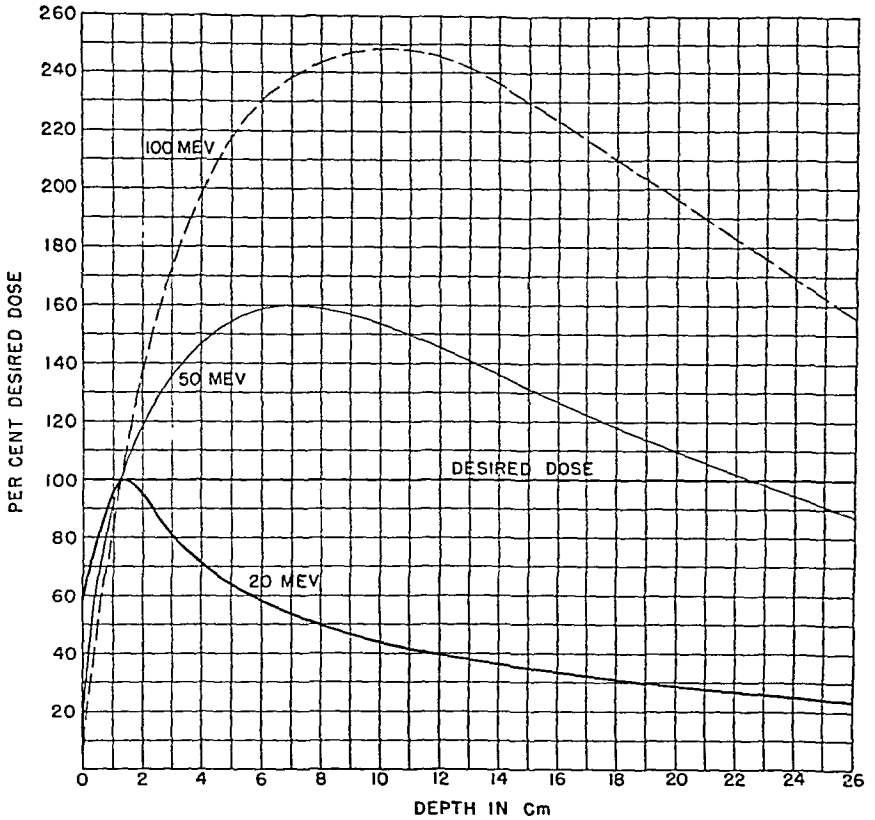


Fig. 11. Energy distribution in the phantom when producing unit ionization intensity at 1.5 cm. depth with 20, 50 and 100 mev roentgen rays.

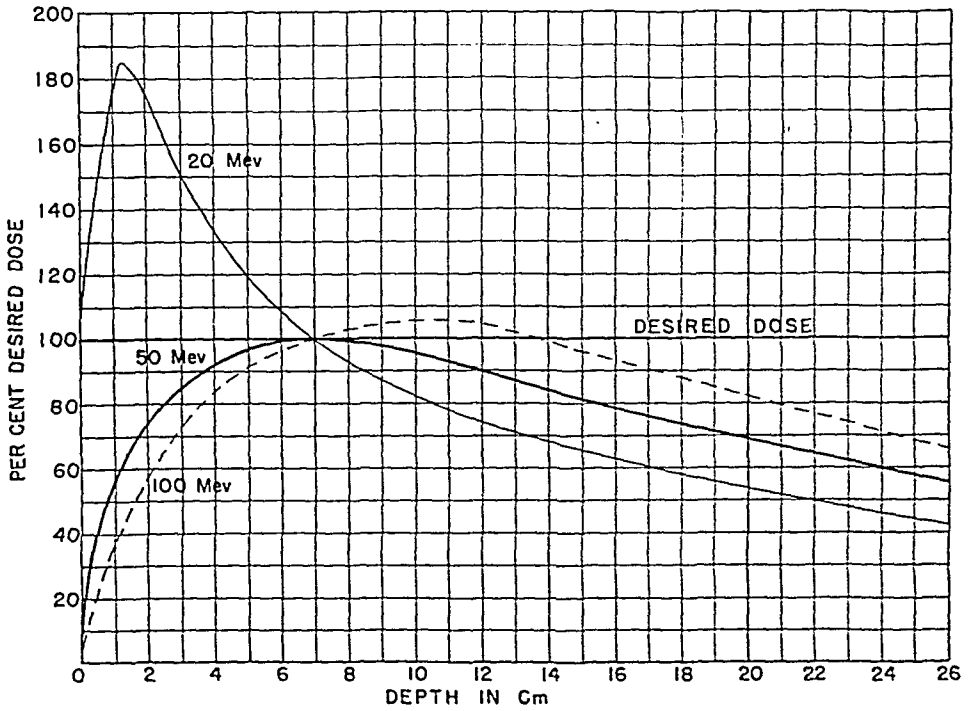


Fig. 12. Energy distribution in the phantom when producing unit ionization intensity at 7 cm. depth with 20, 50, and 100 mev roentgen rays.

radiation at the shortest possible target-phantom distances. With due consideration given to both entrance and exit doses it is possible to choose the appropriate roentgen-ray voltage to cause the peak ionization to occur at any desired depth within the phantom.

Figures 11 and 12 have been replotted from data given in Figure 10 to bring out clearly the value of choosing different roentgen-ray energies when it is desired to get maximum energy absorbed at a specific depth and a minimum absorption elsewhere within the phantom. Using unfiltered radiation, 20 mev roentgen rays are obviously more favorable for 1.5 cm. depths and 50 mev roentgen rays for 7.0 cm. depth.

It should be stressed that the exit dose rather than the entrance dose becomes the limiting factor for energies beyond 30 mev. This will be apparent from Figure 10, from which it can be seen that for the same peak dose the higher the energy the greater the exit dose.

The value of the half intensity angle in the roentgen-ray beam is rapidly decreasing as the roentgen-ray energy level increases. At 20 mev the half-value cone is slightly over 9°; at 50 mev it is 4° and at 100 mev, it is 2°. While the half intensity angle is to some extent dependent on the inherent filtration interposed between the roentgen-ray target and the phantom, it is in the main an inherent property of the mechanism of roentgen-ray generation by electron impact on target bodies at these very high energy levels. Figure 13 shows the angular energy distribution for roentgen-ray voltages ranging from 20 to 100 mev, determined by densitometry of films orthogonally exposed in the phantom at the depth of the peaks for the respective voltages as shown in Figure 10. For any roentgen-ray voltage, the roentgen-ray intensities are very nearly uniform for all points around the circle at any given radius from the axis of the beam. Since the energy distribution is not uniform across the beam

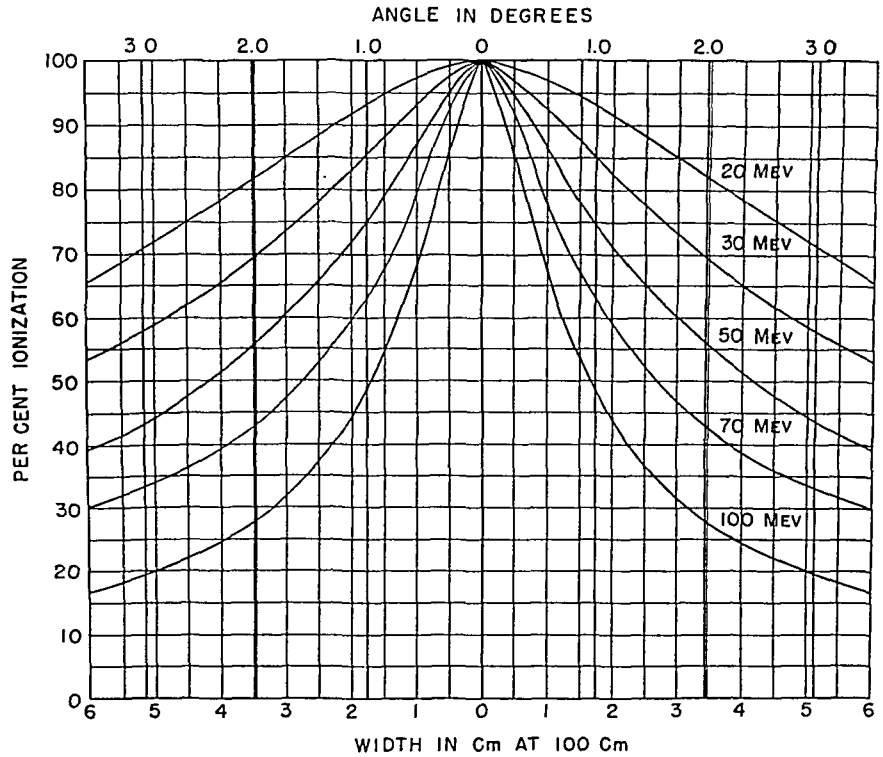


Fig. 13. The per cent ionization at different distances from the axis of the roentgen-ray beam for a target distance of 100 cm. Since the angular width of the beam at any per cent ionization level is independent of target distance, an angular scale is shown also.

it may be desirable to show the size of fields enclosing all intensities down to 80 per cent of the maximum intensity in the center of the beam for different energy levels. Table 1 shows the target-phantom distances that would be required to maintain the ionization intensity above 80 per cent of the maximum value for different roentgen-ray voltages and different sizes of fields.

The distribution of peak ionization in the pressboard phantom will shift to some extent with different target-phantom distances. Figure 14 for 50 mev roentgen rays indicates that with increasing distance the depth for peak ionization and the exit dose at 26 cm. increase slightly. These shifts may be attributed to the inverse square law and indicate the desirability of having the target-phantom distance as short as the distribution of ionization across the desired field will permit. If in Figure 15, we let E be the radiant flux incident per unit area of the primary roentgen-ray beam, then E at any distance in the phantom around the axis of the roentgen-ray beam will be subject to variations due to the distance X and also to absorption in the phantom. The variation due to distance alone is

$$\frac{\delta E}{E}=\left(-2\,\frac{dx}{x}\right)$$

from the inverse square law. The variation due to absorption alone is

$$\frac{\delta E}{E}=(-\mu dx)$$

where μ is the coefficient of absorption in cm^{-1}, and x is the distance from the target to any point in the phantom. If X_1 is the

TABLE I

TARGET-PHANTOM DISTANCE AND FIELD WIDTH ENCLOSING 80 PER CENT OF MAXIMUM IONIZATION FOR DIFFERENT X-RAY VOLTAGES

	X-Ray Field Diameters in cm.					
	1	2	5	10	15	20
Mev	Target-Phantom Distance in cm.					
100	78	156	390	780	1170	1560
50	32	64	160	320	480	640
30	22	44	110	220	330	440
20	14	28	70	140	210	280

Note: Field diameter at 100 cm. is 1.3 cm. for 100 mev; 3.1 cm. for 50 mev; 4.5 cm. for 30 mev; and 7.4 cm. for 20 mev.

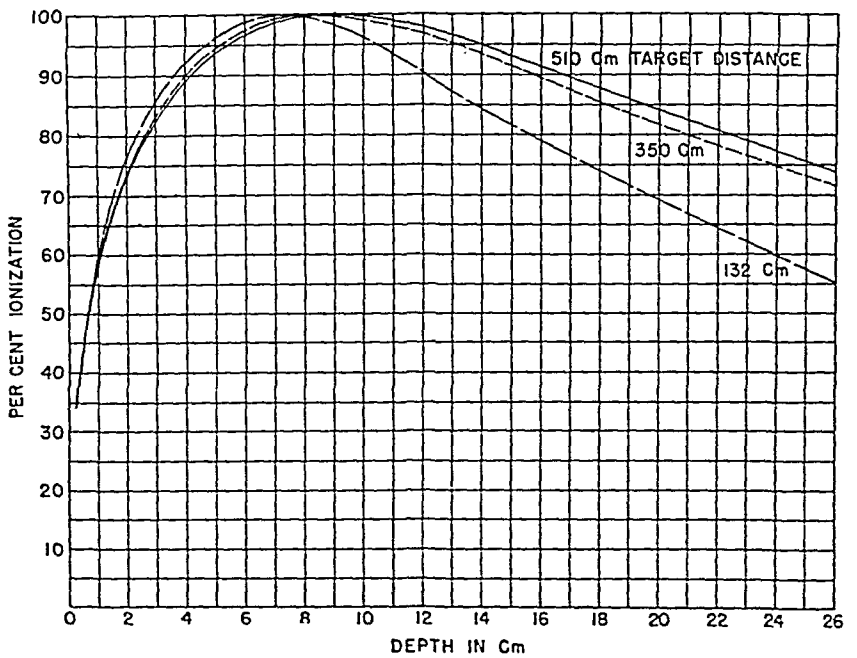


FIG. 14. Effect upon energy absorption of varying the target-phantom distance at 50 mev.

distance from the target to the front of the phantom, then

$$\int_{E}^{E_1} \frac{dE}{E} = \int_{X_1}^{X} \left[-\mu - \frac{2}{X} \right] dx \qquad (1)$$

$$E = E_1 \left(\frac{X_1}{X} \right)^2 e^{-\mu(X-X_1)}. \qquad (2)$$

Thus the radiant flux E incident per unit area at any depth $(X-X_1)$ in the phantom will be equal to the radiant flux incident per unit area on the entrance surface times the inverse square law factor $(X_1/X)^2$ times the absorption factor $e^{-\mu(X-X_1)}$. Since the ionization at any energy and depth is proportional to the primary roentgen-ray beam intensity, any attenuation of the primary beam will cause attenuation of the ionization pattern. This is obscured at depths below the peak, for here as the primary radiation penetrates, it is producing more secondaries and adding them to those previously produced, thus amplifying the ionization. At the peak the secondaries are being absorbed as fast as they are produced, and beyond the peak the decreasing power of the primary roentgen-ray beam to produce ionization becomes apparent. This analysis indicates why the peak and exit ionization varies as it does with target distance at any given energy level. Calculations by equation (2) of the relative exit dose along the axis for different target-phantom distances are found to agree with the experimental value as given on Figure 14 within 2 per cent. From the experimental ionization data as given in Figure 10, one can calculate the ionization intensity at the corresponding depth within the phantom along the axis for different energy levels at any desired target distance. The value of flux E', at a depth $(X'-X_1')$ for any target distance X_1', may be calculated by reading the value of E for the corresponding depth $(X-X_1)$ on Figure 10. For a constant entrance dose the dose E' will vary with position in the phantom according to the equation

$$E' = E \frac{\left(\frac{X_1'}{X'} \right)^2}{\left(\frac{X_1}{X} \right)^2} \qquad (3)$$

since the entrance flux and the absorption terms are the same in both cases.

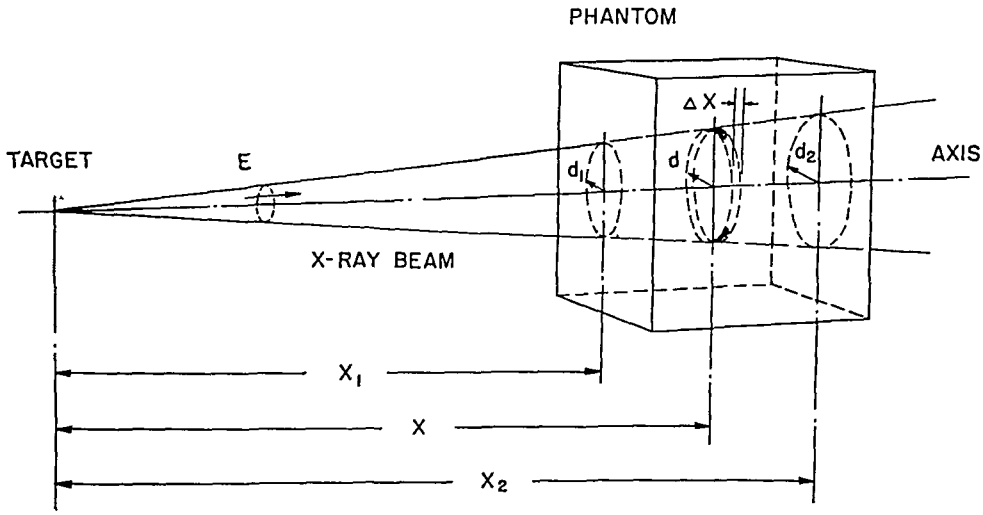


FIG. 15. Schematic diagram for analysis of volume absorption of roentgen-ray beam in phantom.

In addition to the ionization intensity, it may be desirable to know the total amount of ionization or total charge produced in a given volume of the phantom. Since no method of doing this by direct experiment was available, the total charge was calculated by integrating the ionization intensity

over the volume. Similar methods of calculation of this total charge have been described by Mayneord[5,6,7,8]. Where the ionization intensity is not known as an explicit function of position, as in the present case, the integration may be approximated by dividing the total volume into small volumes wherein the ionization intensity may be considered constant, and adding the charges produced in each small volume. The effect upon total absorption due to the

so

$$\Delta V_x = \frac{\pi}{4}\left(\frac{d_1}{X_1}X\right)^2 \Delta X$$

and

$$\mathcal{Q} = \sum_{X_1}^{X_2} \rho_x \frac{\pi}{4}\left(\frac{d_1}{X_1}X\right)^2 \Delta X.$$

To make the calculation feasible it has been assumed that the beam of roentgen rays passes through a circular aperture

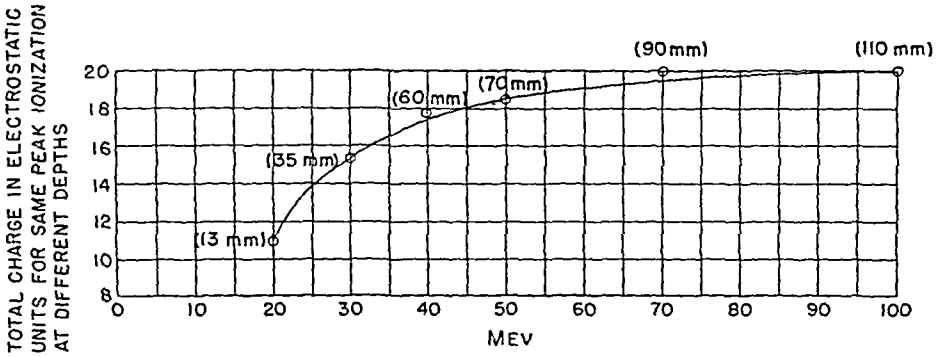


Fig. 16. The total charge in electrostatic units generated in a volume of the phantom 26 cm. deep, 1 cm. diameter at the entrance surface when the maximum ionization density produced in the phantom is 1 electrostatic unit per cubic centimeter. The target distance is 132 cm.

scattered components, and the field size, has not been included in these calculations. While the effect of scattered radiation plays more of a role at lower roentgen-ray voltages,[9,10] such an omission is of less importance at the higher roentgen-ray voltages for scattering is predominantly forward.

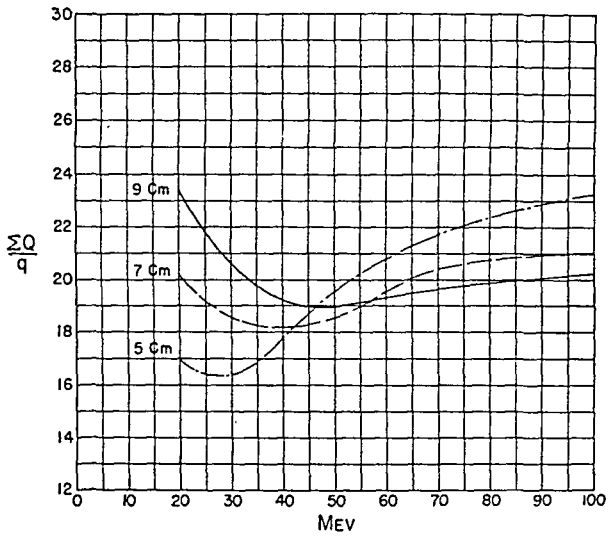
From Figure 15 it is apparent that the total charge generated in the volume of the phantom between X_1 and X_2 will be the sum of the charges generated in volume increments ΔV_x. Thus $\mathcal{Q} = \sum_{X_1}^{X_2} \Delta q_x$ where $\mathcal{Q}$ is the total charge. The increment of charge $\Delta q_x = \rho_x \Delta V_x$ where ρ_x is the ionization intensity at the depth X, and ΔV_x is the volume of the cylindrical disk of thickness ΔX and diameter d. It is apparent that

$$d = \frac{d_1}{X_1}X,$$

which is so constructed and so placed as to produce a conical bundle of roentgen rays 1 cm. in diameter at the entrance skin, across which the roentgen-ray intensity is essentially uniform. Consequently, in the phantom, the volume irradiated will be a frustum of a right circular cone 1 cm. in diameter at the entrance surface, slightly larger at the exit surface, and in this case 26 cm. from entrance to exit. The apex of the cone is at the target 132 cm. from the front of the phantom.

By considering the roentgen-ray intensity to be uniform across the entrance port the calculation will yield the maximum total charge, for actually the intensity falls off as the angle from the axis increases (see Fig. 13). For a distribution range across the field from 100 per cent down to 80 per cent at the edge of the field the total charge values would be reduced by 13 per cent. The maximum total charge separated in the volume of the cone, with the phantom

at 132 cm., has been calculated by the above method at 20, 30, 40, 50, 70, 100 mev and the results plotted in Figure 16. At each roentgen-ray voltage the charge has been calculated for the same unit peak ionization intensity as in Figure 10. Thus if the ionization intensity is in statcoulombs/cm³., the total charge will be in



TOTAL IONIZATION IN PHANTOM PER UNIT INTENSITY AT INDICATED DEPTH

FIG. 17. Total energy absorbed in the conical volume of the phantom to produce unit ionization intensity at the indicated depth.

statcoulombs, or if it is desired to refer to energy absorbed per unit volume in ergs/cm³., the total energy absorbed will be in ergs.

It is apparent from Figure 16 that if unit peak ionization is considered, the total charge separated in the phantom will increase at higher million electron volts. However, as has been indicated in the discussion of Figures 11 and 12 to obtain unit ionization at a desired depth in the phantom, the peak ionization required decreases as the roentgen-ray voltage increases until the peak occurs at the desired depth. When considering unit ionization at a desired depth these two effects work in opposition, the required peak ionization decreasing with increasing roentgen-ray voltage, while the total charge per unit peak ionization is increasing. To illustrate, Figure 17 has been plotted, showing the total charge separated in the phantom at different roentgen-ray voltages if unit ionization is caused at the depth of 5 or 7 or 9 cm. The values for Figure 17 were calculated in the following manner: (1) By reference to Figure 10 the peak ionization required to produce unit ionization at the desired depth was found for 20, 30, 40, 50, 70, and 100 mev, as was done for Figures 11 and 12. To find the peak ionization required to produce unit ionization at 9 cm. depth using 30 mev. referring to Figure 10, the per cent ionization at 9 cm. on the 30 mev curve is 75 per cent. Therefore, to increase the ionization at 9 cm. from 75 per cent to unity (100 per cent) requires multiplication of the exposure by $\frac{1}{0.75}$ or 1.33 times. This gives an entrance ionization of 40 per cent, peak ionization of 133 per cent, and exit ionization of 50 per cent. (2) Now refer to Figure 16 which indicates that for unit peak ionization the total charge at 30 mev will be 15.5 statcoulombs. Therefore, for a peak ionization of 133 per cent, the total charge will be $1.33 \times 15.5 = 20.6$ statcoulombs. This process, repeated for each million electron volts at several depths, is shown in Figure 17. It indicates that there is an optimum roentgen-ray voltage to produce minimum total energy in the irradiated volume while obtaining maximum energy absorbed at each desired depth. Hence the useful fraction of the total energy absorbed is greater at higher voltages. Ungar[13] has emphasized the importance of maintaining the useful fraction at a high value. Comparison with Figure 10 shows this optimum voltage to correspond closely with the voltage which produces peak ionization at the desired depth.

Filters are of course to be considered when working with the electromagnetic spectrum to reduce the intensity of one wavelength component relative to another. Consequently a filter must have the property of selective absorption, which means that the absorption coefficient of the filter must be different at different wavelengths.

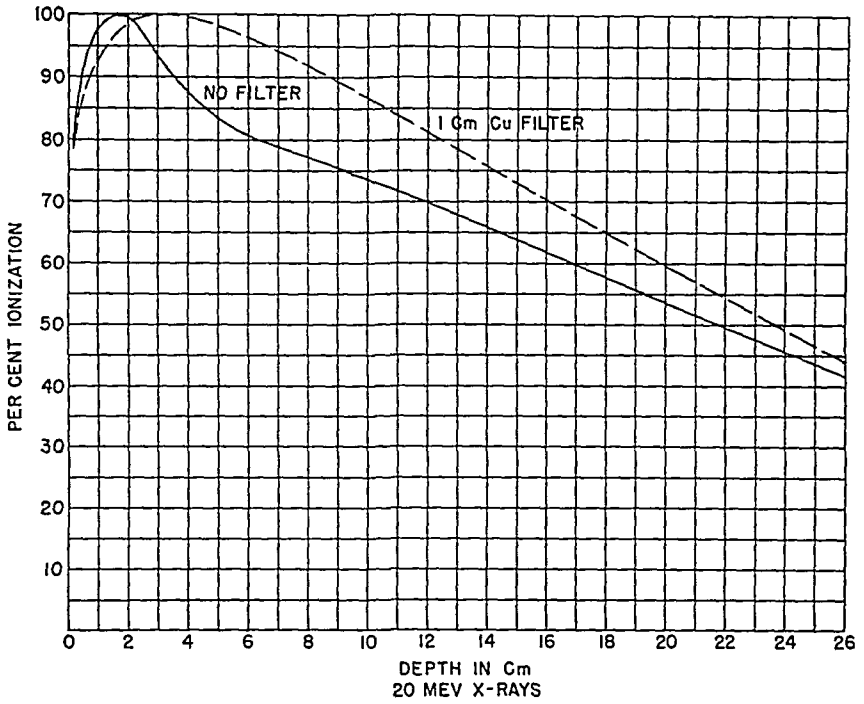


FIG. 18. 20 mev roentgen-ray absorption pattern with copper and with no filter at 196 cm. target-phantom distance.

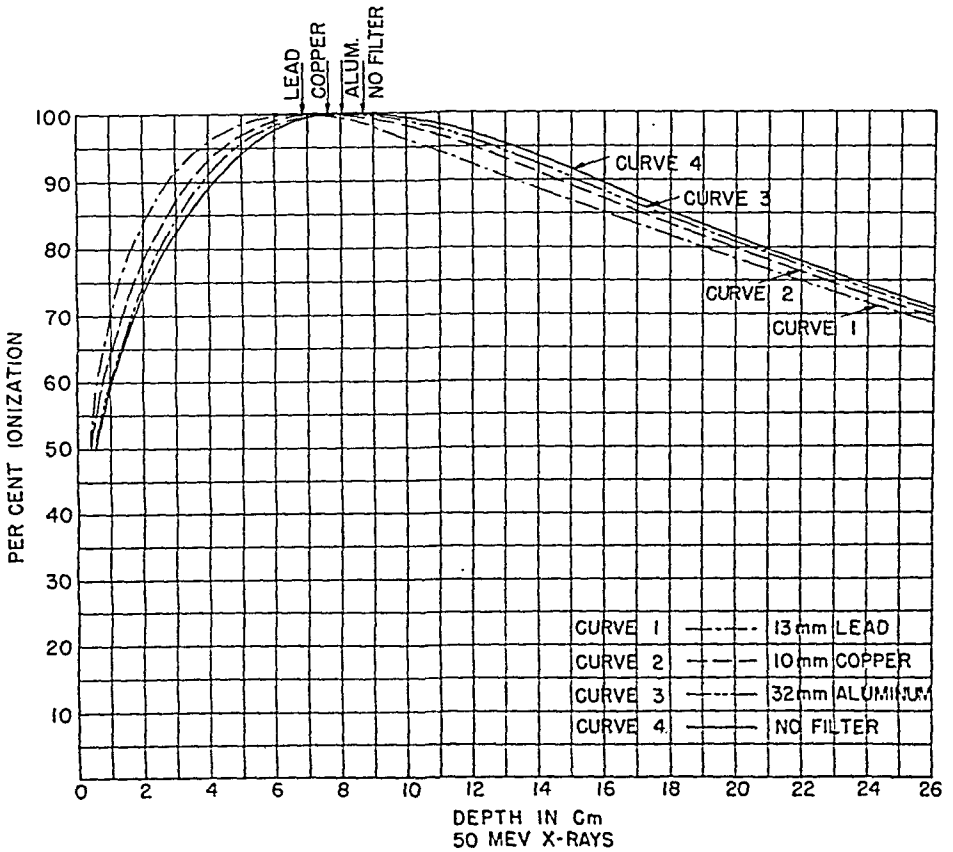


FIG. 19. 50 mev roentgen-ray absorption pattern with lead, copper, aluminum and no filter at 350 cm. target-phantom distance.

Several axial films have been exposed at 20 mev and 50 mev with some filters of lead, copper, and aluminum and the results plotted in Figures 18 and 19, respectively. In doing this work, care was taken to have sufficient space between the filter and the phantom to reduce the screening effect to a low value. This increased the target to entrance skin distance. The copper filter 10 mm. thick used at 20 mev indicates a definite selective absorption of the softer roentgen-ray components and of the spray of electrons emerging from the toroid along with the roentgen rays. The filter experiments with 50 mev were made with lead 13 mm. thick, copper 10 mm. thick and aluminum 32 mm. thick. At 50 mev all of the filters show a slight tendency to soften the radiation, for the peak moves to a lesser depth as it would if lower roentgen-ray voltages were used without a filter. The filter thicknesses in these experiments were chosen to transmit about one-third of the incident radiation. The ineffectiveness of filters at 50 mev was not totally unexpected for previous work on absorption coefficients[14] indicates that the variation of absorption coefficient with wavelength becomes small in this range of roentgen-ray voltages.

IV. CONCLUSION

In conclusion, the depth dose data of these very high energy roentgen rays in a pressboard phantom have clearly indicated that the energy distribution pattern changes very markedly with the large changes in roentgen-ray voltages available. It indicates that there is an optimum roentgen-ray voltage to obtain the maximum ionization intensity at any desired depth. The availability of the great range of roentgen-ray energy levels obtainable from electromagnetic electron accelerators offers the advantages of greater flexibility, enabling one to give maximum ionization at any desired depth, and greater efficiency, giving over a wide range a more favorable ratio of energy absorbed in a particular region to that absorbed in the rest of the volume through which the radiation must pass. The phantom exit absorption may become the limiting factor rather than the entrance absorption in the total dosage problem when applied to therapeutic techniques.

The authors wish to acknowledge the helpful suggestions and criticisms given by Dr. W. D. Coolidge and Dr. G. C. Baldwin, and the able experimental assistance rendered by Mr. H. Mesick.

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A NEW PHOTOGRAPHIC MATERIAL FOR GAMMA-RAY DOSIMETRY*

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PHOTOGRAPHIC methods have been used on a routine basis in this laboratory for estimating exposure of personnel to stray gamma and roentgen radiation. Accidents occurring during the handling of fissile materials made it desirable to supplement the standard dental-type roentgen films being used with some other photographic material having the property of being able to record an integrated gamma-ray dose of a higher order of magnitude. Accordingly, a number of commercially available photographic films and papers were investigated in the hope of finding one sufficiently insensitive for the purpose at hand. "Adlux" film, manufactured by the Defender Photo Supply Company, was found to be of the desired degree of sensitivity, as well as to possess unusual uniformity and reproducibility. This film with standard development gives an extreme readable range of densities in the dosage range of 50 to 15,000 gamma-roentgens.

It became apparent that this range includes the range of dosage of therapeutic interest and that the film should therefore prove useful in the measurement of distribution of radiation intensities about multiple radium sources such as are used in therapy. Such measurements made by means of ionization chamber techniques are tedious, while calculations become very laborious or well nigh impossible when more than a few sources or anything but the simplest geometrical arrangements are considered. Film methods have the advantage that a complete three-dimensional plot of radiation intensity about a source or group of sources may be made in a single exposure. In addition, qualitative investigation of the field pattern about a group of sources may be made rapidly and effects of changes in distribution of sources noted. A permanent record is also provided. The degree of precision is not high but is believed adequate for clinical purposes. Film methods in the past have been handicapped to a degree by the limited range of radiation dosage recordable.

I. GENERAL CONSIDERATIONS IN PHOTOGRAPHIC DOSIMETRY

The extension of the international roentgen, originally defined for roentgen rays, to the gamma-ray region has been validated by the work of Gray[4] and others.[7,11] In particular, the conditions under which thimble-chamber measurements are valid as a measurement of dose in terms of the international roentgen have been clarified. The intensity of radiation about a point radium source of 1 millicurie strength and encased in a 0.5 mm. platinum shield, has been determined to be 8.4 r per hour at a distance of 1 centimeter.

Photographic measurements of radiation dose must be calibrated in terms of the primary ionization measurements. There is unfortunately no simple and direct relationship between film blackening and radiation dose. In general, the photographic effect is dependent upon photon energy, the emulsion blackening for unit dose decreasing with increasing photon energy.[1,2,5] There are in addition sharp discontinuities in the curve of specific blackening against

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wavelength in the region of the absorption edges of bromine and silver, at 14 and 25 kv., respectively.[10]

Photographic photometry of visible light has been complicated by failure of the reciprocity law of Bunsen and Roscoe, which defines the exposure as equal to the product of intensity by time and implies that equal exposures should result in equal emulsion blackening. It has been shown by Bell,[1] however, that the photographic effect of a given dose is independent of the dosage rate over a range of roentgen-ray intensities varying by a factor of ten thousand. This point has also been investigated by Morgan.[8]

It is customary to plot the characteristic curve of film in the manner suggested by Hurter and Driffield, namely, density as a function of the logarithm of the dose. When this is done an S-shaped curve is obtained which over a considerable portion of the range approximates a straight line. Bell[1] has also shown that the shape, but not the position, of this curve depends only on the characteristics of the film material and development conditions, and is independent of wavelength.

There are many potential sources of error in photographic methods. Uniform development technique with control of temperature and agitation is of utmost importance in obtaining reproducible results.

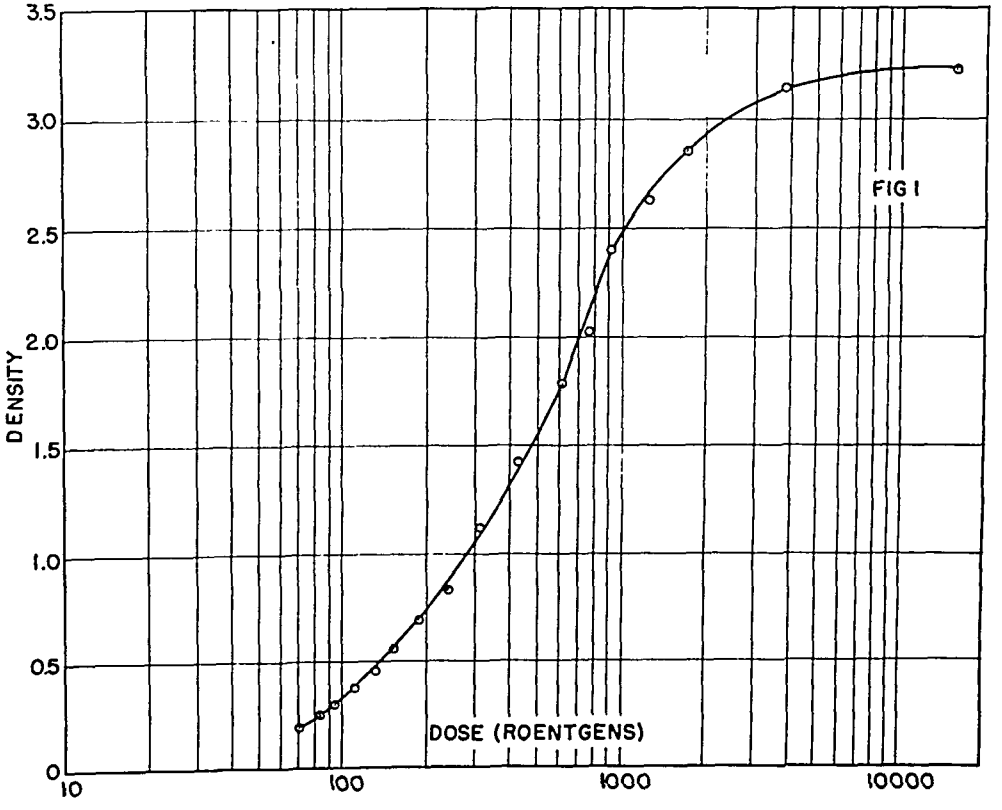


FIG. 1. Characteristic curve of "Adlux" film in air.

Wilsey[10] has discussed in detail the technical requirements that must be met in photographic methods of measurement of roentgen-ray dose.

II. MATERIALS AND METHODS

"Adlux" film consists of a transparent safety base double coated with a bromide type of emulsion similar to that used in projection printing papers. A diffusing medium has been added to the film emulsion, which gives it a translucent appearance. The film is designed for the production of advertising display transparencies. The base stock is 0.015 cm. in thickness,

and the emulsion layers average about 15 microns in thickness. The grain-aggregate size in the developed film varies between approximately 0.5 and 0.7 micron. The film has a matte surface which has incidentally proved useful through the readiness with which notations and construction lines may be made directly on the film. The film was ordinarily handled in the form of 8 by 10 inch sheets.

Tray development in Eastman formula D-72 developer was used. One part of the stock solution was diluted immediately prior to use with two parts of distilled water. Development was carried out at 20° C. for three minutes, with constant agitation. The sheets were passed rapidly but one at a time into a tray containing the developing solution and agitation maintained by repeatedly withdrawing the bottom sheet and replacing it on top of the stack. At the conclusion of the development period the films were quickly transferred to a dilute acetic acid short-stop bath and thence to a standard fixing solution (Eastman Formula F-5). Following complete fixation the films were washed in water and suspended in air to dry. A blank sheet of film was processed with each batch.

Density measurements were made using a "Photovolt" photoelectric densitometer. This instrument incorporates a diffuse illuminating system, phototube and amplifier, with a direct-reading scale calibrated in density units. The primary range of the instrument is from density 0 to 2.0, with provision for extending the range to about 3.2 by resetting the zero point.

The source used in the film calibration studies consists of 500 millicuries of radium bromide, enclosed in a hard-soldered silver cylinder $\frac{5}{8}$ inch in diameter by $\frac{3}{8}$ inch in height. The wall thickness of the container is 1 millimeter. When measurements were made in air using a standard Victoreen condenser r-meter, with 25 r chamber brought approximately to electronic equilibrium by the addition of a plastic cap 3 mm. thick, a radiation dosage rate of 39.0 r per hour was measured at 10 cm. Under phantom conditions a dosage rate of 38.0 r per hour was found at 10 cm. A correction factor of 1.3 has been included as a multiplier of the observed readings to convert to the standard pressure of one atmosphere. The barometric pressure at this location averages 590 mm. of mercury.

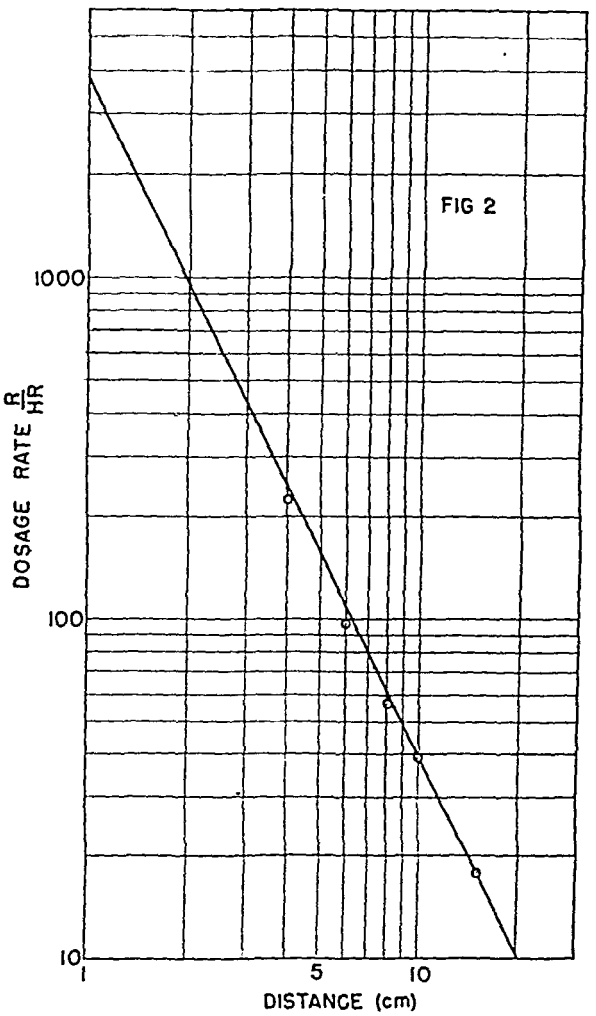


Fig. 2. Inverse-square law curve in air. Circles represent values measured with the ionization chamber, as described in the text.

Film exposures were made both in air and in a phantom of Masonite "Presdwood." For exposures in air the film was enclosed in two thicknesses of black protective paper and it and the source were supported on a thin sheet of cellulose acetate at a distance from any dense scattering material. The phantom was made up of $\frac{1}{4}$ inch slabs of "Presdwood," and was so arranged

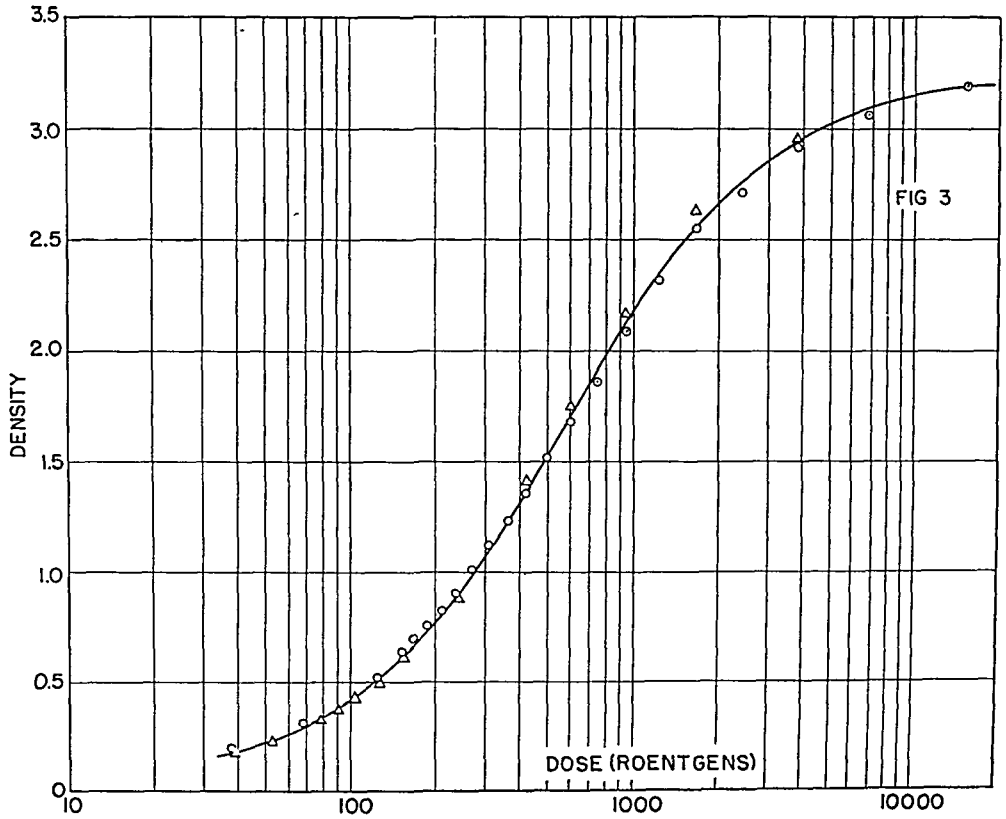


FIG. 3. Characteristic curve of "Adlux" film in "Presdwood" phantom.

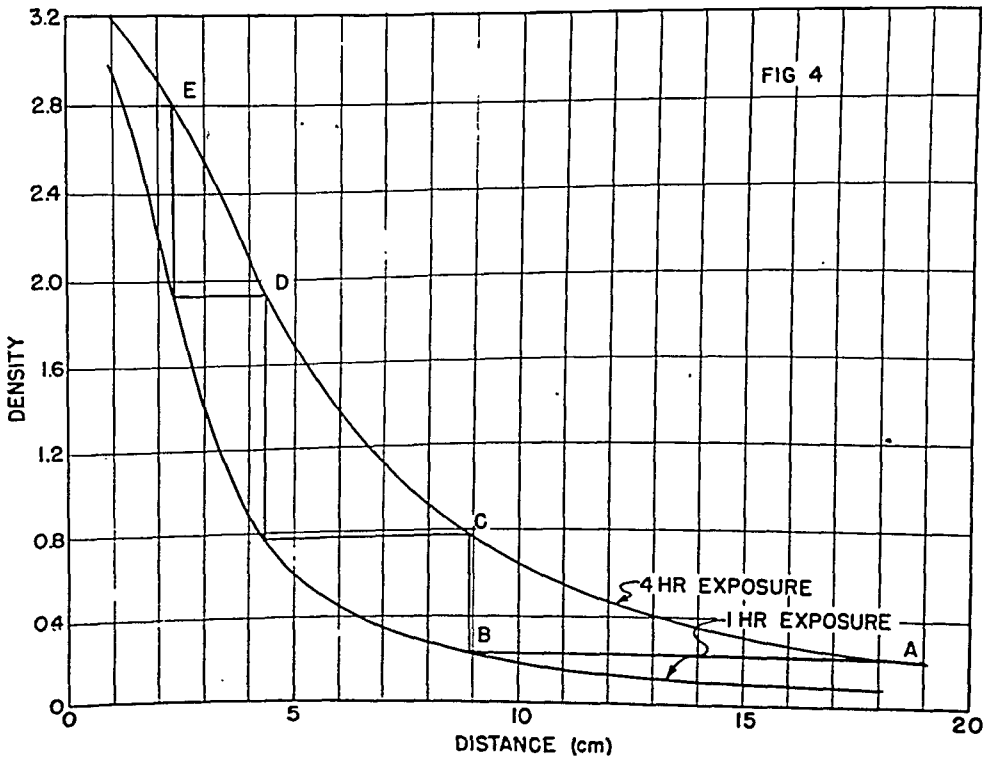


FIG. 4. Density vs. distance curves for one hour and four hour exposures in phantom.

that air spaces were avoided, and the film and source were enclosed on all sides by at least 10 cm. of absorbing material. Reference points on the film were located by pin holes punched in the paper packet enclosing it.

III. RESULTS

Figures 1 and 3 give the characteristic response curves of this emulsion material in air and under phantom conditions respectively.

In determining the response curve in air the inverse-square law was assumed valid for distances rather greater than the physical dimensions of the source. The source was placed at one end of the film packet and a four hour exposure made. The film was then processed and its density at various distances from the center of the source measured. In Figure 2 the computed dose rate against distance curve is shown together with the values measured by the thimble chamber. From this and the observed density against distance relationship the density against logarithm of exposure curve in Figure 1 was drawn.

Figure 3 shows the similar response curve under phantom conditions. Here no assumptions were made concerning the form of the radiation field surrounding the source. One hour and four hour exposures were made and density against distance relationships are plotted in Figure 4. It is apparent that any horizontal line drawn on this chart cuts the two curves at points of equal density and hence, assuming the reciprocity law valid, at points of equal radiation dose; while any vertical line cuts the two curves at points where the dosages are in the ratio of four to one. Hence, if point A be assumed to correspond to a dose of one unit, point B received this same dose and point C, four units. Similarly, point D received sixteen units and point E, sixty-four units. The log-log plot in Figure 5 shows no significant deviation from the straight line of slope -2 predicted by the inverse-square law out to a distance of 19 cm., fitted to the experimentally determined value of 38 r per hour at 10 cm. On this same plot are shown the dosage rates determined by the thimble chamber at various distances. From it the density against log exposure curve in Figure 3 was determined. The circles enclose points determined from the one hour, and the triangles, points from the four hour exposure.

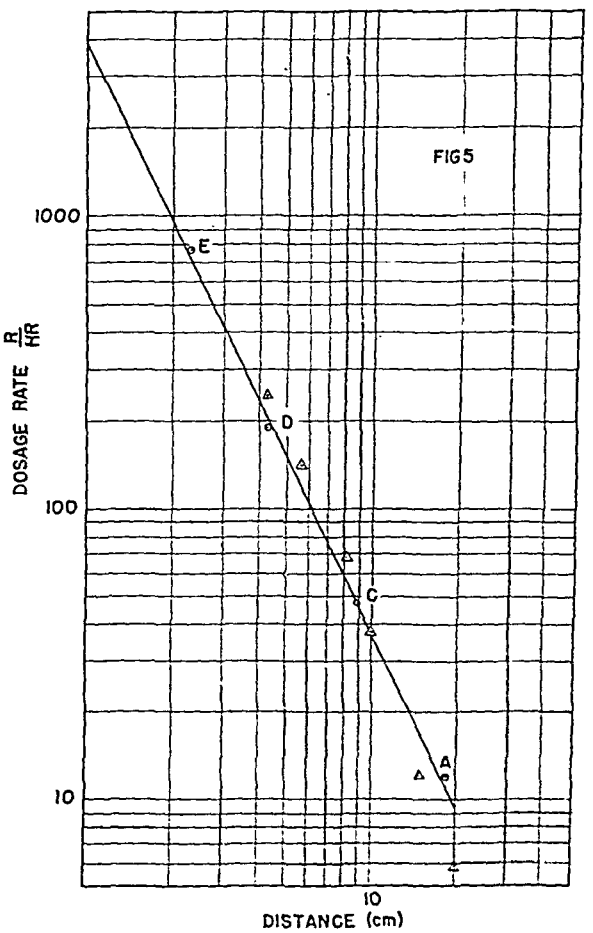


FIG. 5. Distance vs. dose in phantom. *Solid line:* inverse square law. *Circles:* values by film measurement. *Triangles:* values by ionization chamber.

A final experiment was performed to show the ability of the film to record the radiation field about multiple sources such as might be used in gamma-ray therapy. The arrangement chosen for investigation was that of three linear sources in a tandem arrangement. Actually a single source (NBS No. 13078) was used and was moved successively to its two new positions during the exposure. This source contains 9.92

milligrams of radium in a platinum needle 0.5 mm. in wall thickness and 1.75 cm. in length. Its active length is 1.5 cm. In the figure (Fig. 6) three sets of isodose curves are drawn: (1) the experimentally determined set; (2) calculated isodose curves

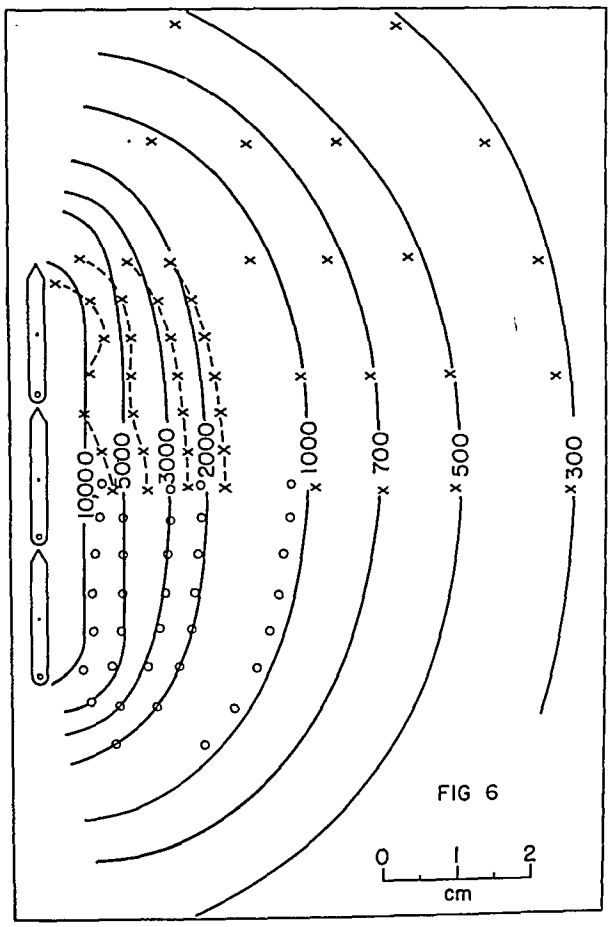


FIG. 6. Dosage rates about tandem (see text). *Solid lines:* photographic method. *Circles:* Quimby's data. *Crosses:* approximate calculation (see text).

from the data given by Quimby[9] for a uniform source of 5 cm. length; and (3) calculated curves determined by replacing each source by an equivalent point source at its geometrical center and adding the contributions of each at each point of interest. It is seen that there is substantially good agreement between the experimental and the calculated curves.

In all such measurements it is absolutely essential for accurate results that a calibration film and a blank be processed with each batch.

IV. DISCUSSION

It is surprising to note that this film method shows such close agreement with the inverse square law out to such large distances (approximately 20 cm.) in the phantom. At such distances, differences due to absorption are large and are readily measurable when an ionization chamber is used. The agreement is purely fortuitous and must be due to an increased sensitivity of the film to scattered radiation of longer wavelength. However, there is good agreement with ionization chamber measurements out to distances (approximately 10 cm.) which are likely to be of clinical interest.

Investigation of the response of this film to a wide range of photon energies (50 kv. to 20 mev.) is under way, and will be reported in the future. Preliminary work indicates that there is no significant difference in the response of the film to the primary radiation of radium, which has an average energy of 0.7 mev., with photon energies ranging from 0.3 to 2.5 mev., on the one hand, and to the gamma radiation from Co^{60} which has well defined photon energies of 1.1 and 1.3 mev.

V. CONCLUSIONS

Gamma-ray dosimetry with the aid of a special, commercially available film has been discussed. This film has been shown to have unusual latitude and reproducibility. Characteristic curves for this material both in air and under phantom conditions are presented. The use of this material for investigation of the radiation field about complex arrays of sources is feasible and the method is capable of giving results well within clinical tolerances of accuracy.

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SOME CONSIDERATIONS IN THE TREATMENT OF HEMANGIOMA IN INFANTS AND YOUNG CHILDREN*

By EUGENE P. PENDERGRASS, M.D., JAMES C. KATTERJOHN, M.D.†, *and* JAMES B. BUTCHART, M.D.

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HEMANGIOMA of the skin or mucous membrane is a lesion familiar to every doctor. It is a benign vascular tumor which should receive treatment because of the cosmetic deformity or because it interferes with function. The condition is congenital and the most important thing about the lesion is that whatever treatment is given should be given early, that is, as soon after birth of the infant as possible, or as soon as the blemish appears.



FIG. 1. Photomicrograph showing marked cellularity in a hemangioma. The endothelial channels are numerous and many of them do not contain blood. This type of lesion is thought to be capable of further growth. Clinically a lesion of this type is indistinguishable from a less cellular lesion. (Microscopic slide loaned by Dr. Robert C. Horn, Surgical Pathologist, Hospital of the University of Pennsylvania.)

A hemangioma is a localized hyperplasia of the cutaneous or subcutaneous vascular tissue. The lesions may involve the dermis, the subcutaneous tissue, or both. They range greatly in size, are reddish or purplish in color, with a flattened surface, which is on a level with the skin or slightly elevated above the general level.

Growth of hemangiomas is thought to be accomplished by budding of vascular channels and proliferation of endothelial cells. In some of these lesions, proliferation becomes a major consideration (Fig. 1).

Vascular nevi may be separated on an anatomic basis into three groups[11] (1) flat or slightly elevated tumors composed of a superficial plexus of dilated capillaries, angioma simplex, naevus flammeus; port-wine stain; (2) hypertrophic angiomas, made up of an interlacing network of blood vessels of considerable size, angioma plexiforme; angioma simplex hyperplasticum; and (3) cavernous hemangiomas.

The simple angioma, as a rule, appears shortly after birth.

The "port-wine stain," or *naevus flammeus*, occurs as several varieties. Experience with Chaoul roentgen therapy in treating pink lesions in the very young is most encouraging. The deeply colored lesions are helped only slightly. The skin is thin in this type of lesion, and the vessels are thin walled and superficial, situated immediately beneath the epidermis. The endo-

* From the Department of Radiology, Hospital of the University of Pennsylvania, Philadelphia, Pa. Presented at the Twenty-ninth Annual Meeting, American Radium Society, Atlantic City, N. J., June 9–10, 1947.

† Trainee of the National Cancer Institute.

thelial lining of the vessel walls is quite thin and thought by some to be radioresistant because of its mature adult type of endothelium[12] (Fig. 2).

The *hypertrophic vascular nevi* and the *cavernous hemangiomas* may be discussed together. They are more or less elevated with a nodular or lobulated surface. The tumors vary in size and color, are soft and compressible. Swelling of the lesion can be produced or increased by gravity, exertion

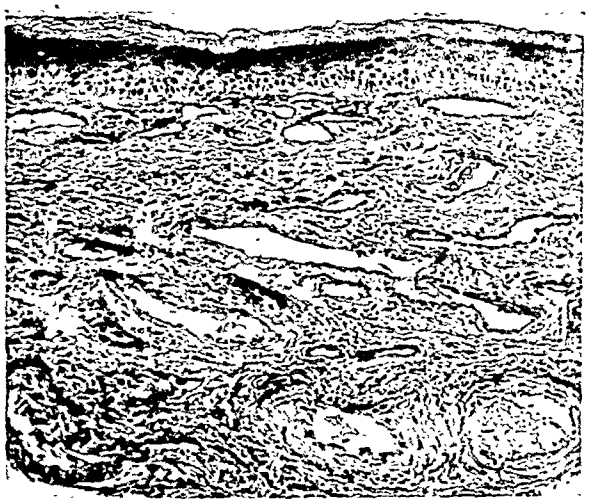


Fig. 2. Photomicrograph of a "port-wine stain." Numerous vascular channels with mature adult type endothelium are seen just beneath the epidermis. (Microscopic slide loaned by Dr. Herman Beerman, Assistant Professor of Dermatology, University of Pennsylvania.)

or crying. The lesion may ulcerate or rupture and may produce severe hemorrhage. The lesions develop slowly and may cause serious alteration, hypertrophy, or destruction of the tissues by altering the blood supply. They may occur anywhere.

The lesion may be composed of thin-walled dilated capillaries, having a single afferent vessel, or it may have many of the larger vascular components such as arterioles and small arteries and veins (Fig. 3, 4 and 5). The results in treating these lesions (strawberry mark) are gratifying.

THERAPEUTIC CONSIDERATIONS

Over the years, a great many physicians have elected not to recommend treatment



Fig. 3. Photomicrograph of a naevus vasculosis or "strawberry mark" showing blood-filled dilated capillaries. This type of lesion responds well to treatment. It will blanch readily on light diascopic pressure. (Microscopic slide loaned by Dr. Robert C. Horn, Surgical Pathologist, Hospital of the University of Pennsylvania.)

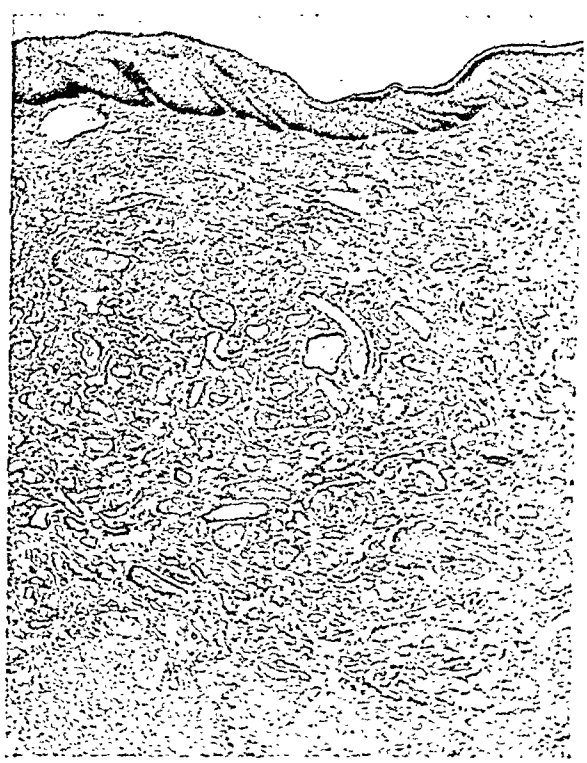


Fig. 4. Photomicrograph showing a cavernous hemangioma which contains arterioles, venules, and small arteries. (Microscopic slide loaned by Dr. Herman Beerman, Assistant Professor of Dermatology, University of Pennsylvania.)



FIG. 5. Photomicrograph showing large veins found in some of the cavernous hemangiomas. This type of lesion is more resistant to treatment by roentgen rays and radium. (Microscopic slide loaned by Dr. Robert C. Horn, Surgical Pathologist, Hospital of the University of Pennsylvania.)

for cavernous hemangiomas, largely because they have been taught that most of the hemangiomas will disappear spontaneously. Indeed, Lister,[4] in 1938, states that he observed 77 patients for seven years, and in that group, over one-half of the angiomas disappeared completely and in the other half the lesions stopped growing and showed evidence of retrogression. Nancel-Pénard[5] and Winer[13] are in agreement with the views expressed by Lister.

While preparing this article, one of us received the following letter:

> . . . It is mildly depressing to me to learn that another paper on the radiation treatment of hemangiomas is going to be written when even the immediate results by radiation are inferior to CO_2 snow.
>
> One has to treat hundreds of patients and live fifteen or twenty years to see the twisted faces, short arms and legs, and small hands to realize how unjustifiable the method is. Can't you possibly read a paper about anything else?

The writer of this letter, a distinguished member of this Society, perhaps is not alone in his belief and there are those who are in complete sympathy with his views. To us, this is a challenge. We believe that hemangiomas can be treated with radiation with complete satisfaction. The poor results that encourage statements like the above can be avoided if a little common sense is used in planning the treatment. We know this because we have observed our results over a period of twenty years and in no instance have we obtained unsatisfactory results that can be attributed to irradiation.

There is no doubt that some of the lesions do heal spontaneously, but it is not possible to predict with assurance which lesions will remain quiescent, grow or disappear spontaneously. Even if it were known that 50 per cent or more of the lesions would disappear, we still would recommend irradiation for the following reasons: (1) radiation can be administered without harmful effects; (2) small doses of radiation will enhance any natural tendency of the lesion to disappear; (3) the results are excellent and are superior to any other method that we have observed. A physician has no right to deny treatment to a patient because of the hope that the lesion will disappear without treatment.

We have seen many hemangiomas in adults, many on the faces of young women, who when the histories were taken, stated that their parents were advised by the family physician, and often by a dermatologist, that treatment should be deferred until the baby was older or that the condition would disappear without treatment. Such advice, we believe, will lead many times to tragic situations, especially in girls.

The methods of therapy for the various types of hemangioma by others include: (1) surgical excision; (2) roentgen therapy; (3) radium therapy; (4) grenz rays; (5) carbon dioxide snow; (6) injection of sclerosing solutions; (7) tattooing (Conway and Docktor[2]); (8) ultraviolet radiation under pressure; (9) electrocoagulation, and (10) cosmetic disguise.

For many years we used radium needles, molds and plaques in the treatment of cavernous hemangiomas. It is a commendable form of therapy and many excellent results were obtained. Since 1937, when Chaoul equipment was acquired by us through the generosity of Mr. William H. Donner, we have used contact roentgen therapy in place of topical radium, and we have been pleased with our results. Our comments in this presentation will be limited to a discussion of contact roentgen therapy, 100 to 140 kv. intermediate roentgen therapy and radon implantation in certain hemangiomas.

Our experience since 1938 consists of the treatment of 560 hemangiomas in 406 patients. The distribution of these lesions is illustrated in Chart 1.

We wish to emphasize at this point, and we will emphasize it again, that hemangiomas are most effectively treated when the patient is seen early, and by early we mean the first few weeks of life. We do not believe in watchful waiting. A hemangioma treated at three weeks of age requires less treatment and responds better than one treated at three months.

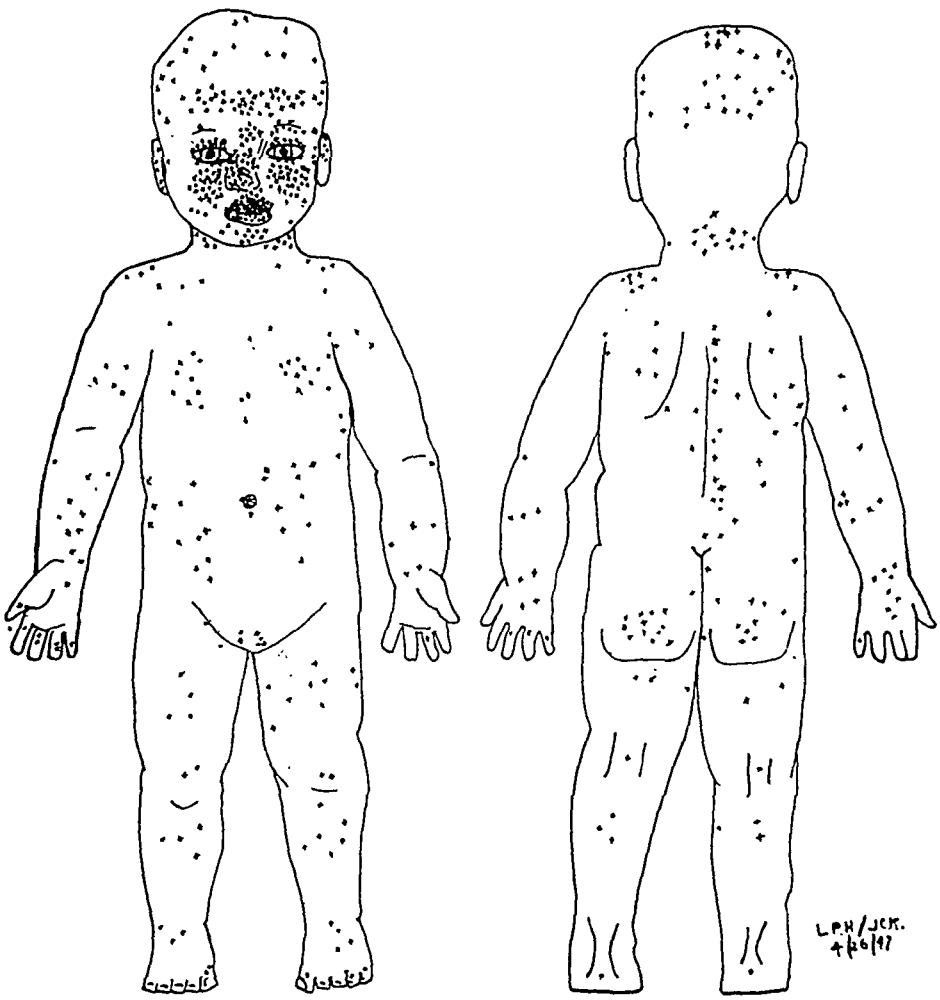


CHART 1. Distribution of 560 hemangiomas in 406 patients treated since 1938 by contact therapy and/or interstitial radon tubes.

In general, the technique we employ may be divided into two parts: (*a*) control of the superficial or dermal elements by roentgen therapy, and this part should be done first, and (*b*) control of the deeper portions of the lesion by implantation with radon seeds or

use of intermediate voltage therapy. The best cosmetic effect is obtained when the superficial portions of the lesion are treated very early. The earlier this portion of the lesion is treated, the better the result. In general, the lesions which respond best are those which easily blanch with light diascopic pressure. They are the lesions with the small vascular channels just beneath the skin, and are easily obliterated by irradiation.

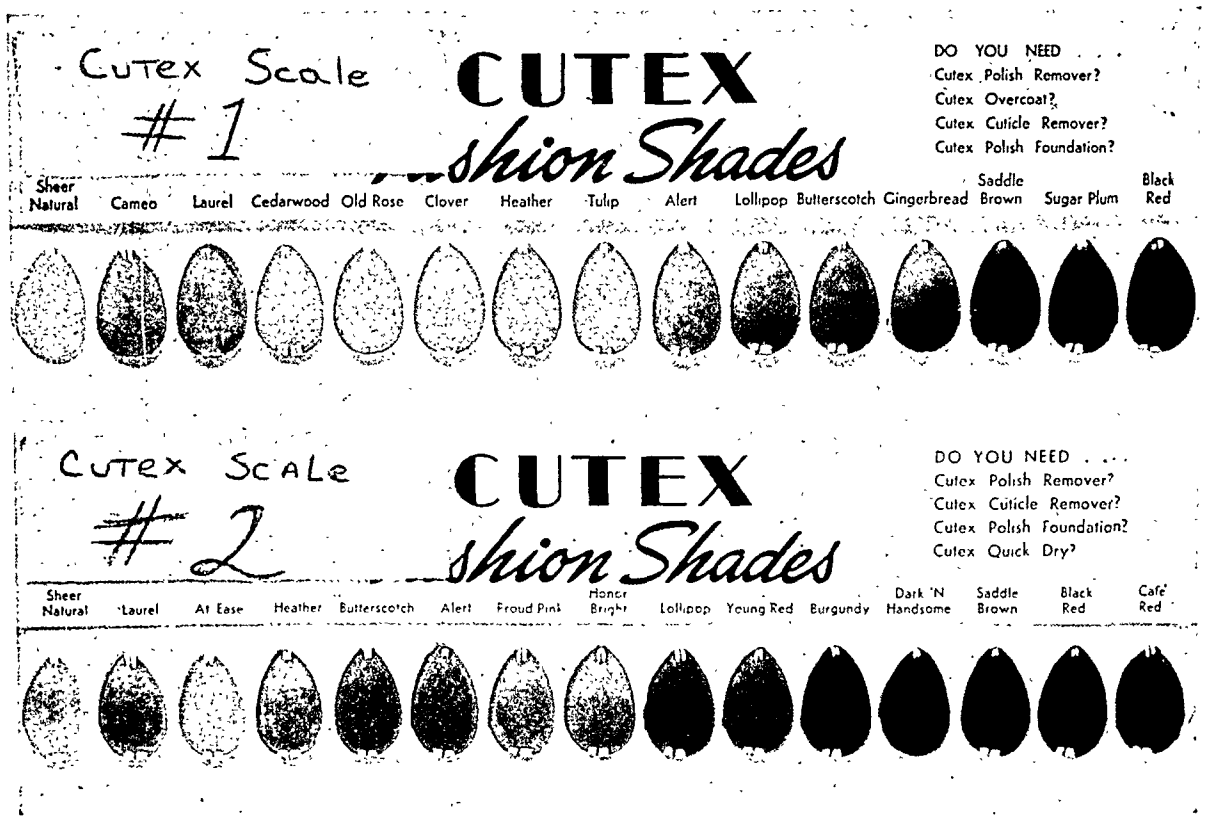


FIG. 6. Sample finger nail polish scale furnished by Cutex. Accurate color matching is possible when these scales are used and minute changes are noted in the treated hemangiomas at the time of each visit. These color charts may be obtained from the finger nail polish manufacturers.

At the time of the first visit, the patient is given a general physical examination. The contour of the hemangioma is traced upon a piece of transparent paper and its measurements are recorded. Color photographs are made. The color of the lesion is recorded, having been matched with a color on one of the finger nail polish scales by the parents and by the radiologist (Fig. 6). The treatment that we recommend is given over a period of months. The anticipated changes (flattening of the lesion, loss of original color and appearance of white skin) are explained to the parents. The change occurs so slowly parents may overlook them until the comparative colors illustrate the gradual skin blanching. These small details have assisted in preventing impatience on the part of the parents. The lesion is tested for blanching with diascopic pressure. If the lesion is not completely blanched by pressure the prognosis for complete disappearance should be guarded. Changes in size or color are noted when the patient is inverted and during crying. If the lesion is situated over some epiphyseal center or closely over any growing bone, a roentgenogram is made of the area and, if it is an extremity, a roentgenogram of the normal opposite extremity is made. Irradiation can disturb the growth of bone; therefore, one should explain such possibilities to the parents. We have had

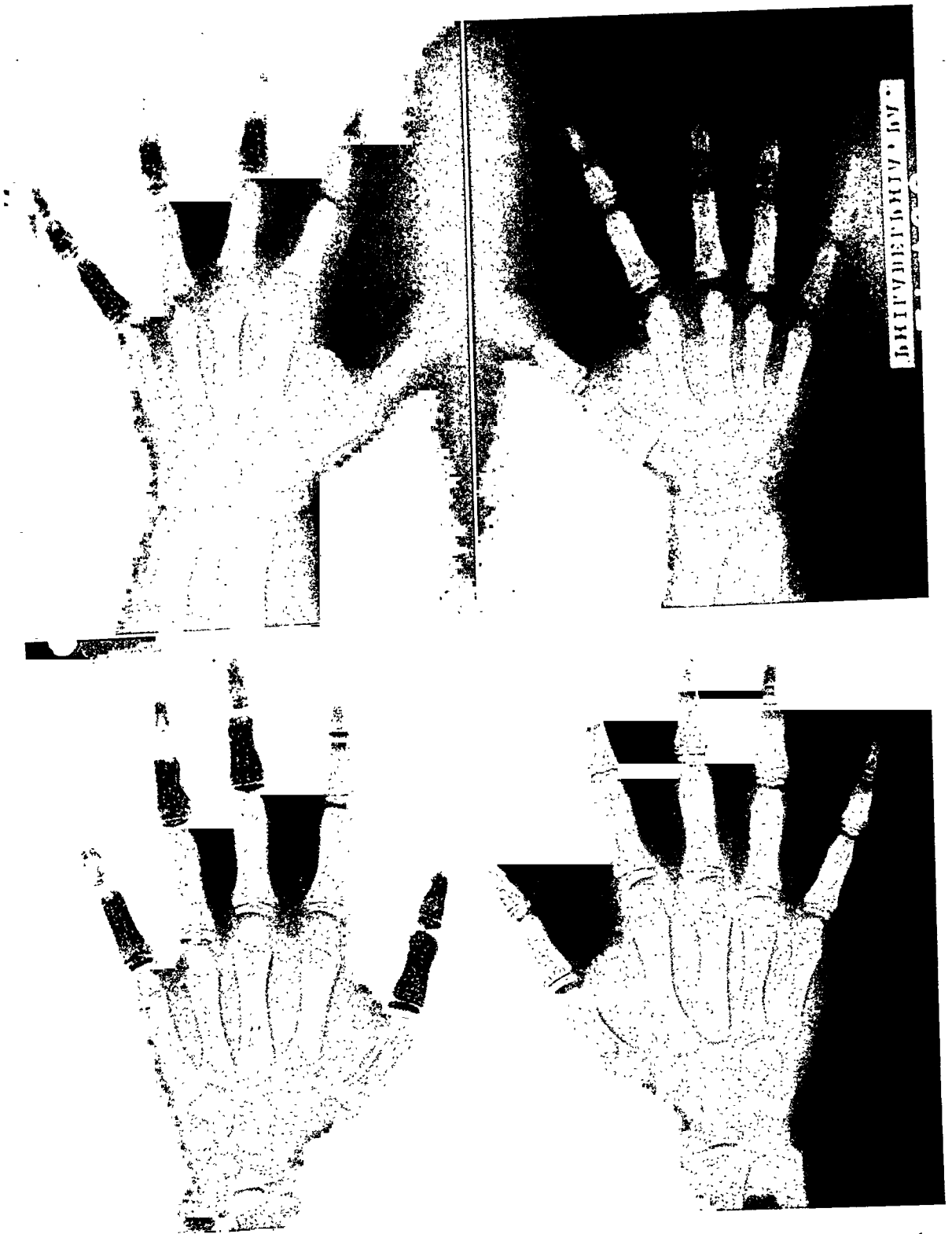
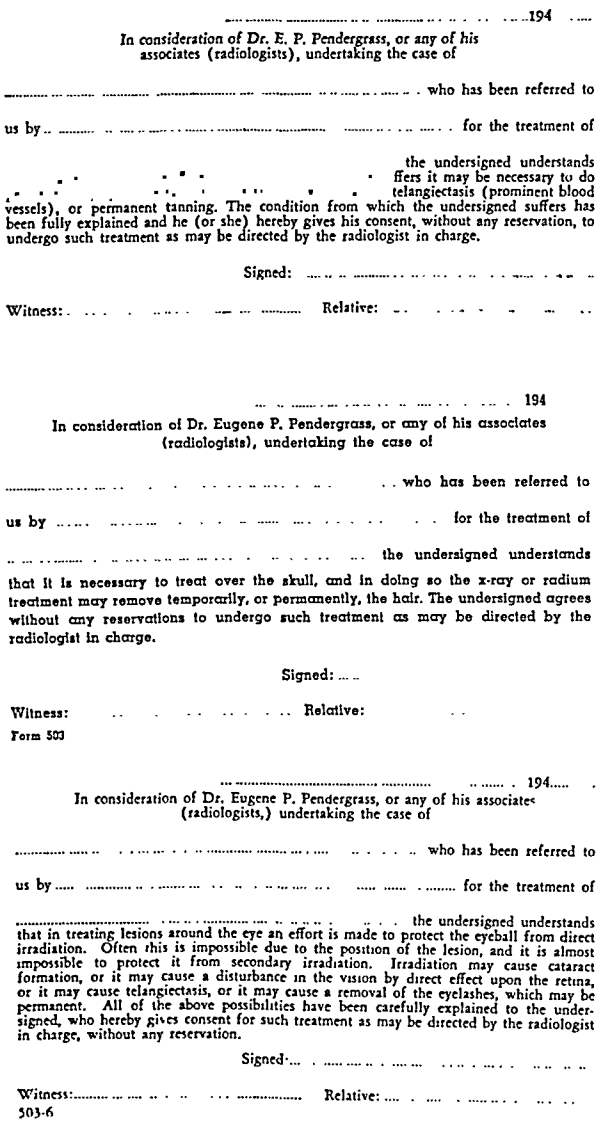


FIG. 7. Roentgenograms made at three and eight years. The patient received 900 r to multiple portals over the right hand on the palm and dorsum at the age of three months. There has been no injury to the bones and no retardation of growth attributable to the irradiation. Many patients have been followed for longer periods than this and have received more treatment without bony change.

no such complications and they are not likely with the method that we employ (Fig. 7). We have observed many instances of overgrowth of bones due directly to untreated hemangiomas, a fact which



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In consideration of Dr. E. P. Pendergrass, or any of his associates (radiologists), undertaking the case of

..... who has been referred to

us by for the treatment of

..... the undersigned understands
..... ffers it may be necessary to do
..... telangiectasis (prominent blood
vessels), or permanent tanning. The condition from which the undersigned suffers has been fully explained and he (or she) hereby gives his consent, without any reservation, to undergo such treatment as may be directed by the radiologist in charge.

Signed:

Witness: Relative:

..... 194

In consideration of Dr. Eugene P. Pendergrass, or any of his associates (radiologists), undertaking the case of

..... who has been referred to

us by for the treatment of

..... the undersigned understands that it is necessary to treat over the skull, and in doing so the x-ray or radium treatment may remove temporarily, or permanently, the hair. The undersigned agrees without any reservations to undergo such treatment as may be directed by the radiologist in charge.

Signed:

Witness: Relative:

Form 503

..... 194.....

In consideration of Dr. Eugene P. Pendergrass, or any of his associates (radiologists,) undertaking the case of

..... who has been referred to

us by for the treatment of

..... the undersigned understands that in treating lesions around the eye an effort is made to protect the eyeball from direct irradiation. Often this is impossible due to the position of the lesion, and it is almost impossible to protect it from secondary irradiation. Irradiation may cause cataract formation, or it may cause a disturbance in the vision by direct effect upon the retina, or it may cause telangiectasis, or it may cause a removal of the eyelashes, which may be permanent. All of the above possibilities have been carefully explained to the undersigned, who hereby gives consent for such treatment as may be directed by the radiologist in charge, without any reservation.

Signed:

Witness: Relative:

503-6

FIG. 8. Sample cards which parents are asked to sign before treatment is given.

also should be explained to the families of the patient, especially by those who do not recommend irradiation.

It is well to tell the parents that occasionally the large boggy hemangioma may break down and "slough." If sloughing occurs following treatment, the family and referring doctor are likely to attribute the destruction of tissue to the irradiation. We have seen more sloughing hemangiomas occur without irradiation than with it. Nevertheless, such a possibility is explained to every patient. We are sure that such practice will obviate mediolegal complications. In our experience, sloughing has occurred only in the large bulky and boggy lesions. Sloughing areas always heal, but leave white scars. They must be cared for to prevent secondary infection.

When lesions occur on the scalp or around the eyes, the family is advised about the possibility of hair falling out and not returning. The parents are asked to give a signed permission before treatment is begun (Fig. 8). Likewise, radon implanted into the orbit might injure the eye. We tell the family of such possibilities and ask for signed permission before proceeding with the treatment. Thus far, we have had no eye injuries and only one patient in which the eyelashes failed to return. There is no danger to the brain in treating hemangiomas of the scalp with the method to be described. In certain large hemangiomas which involve the face and scalp unilaterally, the hemangioma may extend into the brain and lead ultimately to hemiatrophy. Roentgenograms of the skull are obtained in such instances and at frequent intervals. The family are completely informed about the possibility of hemiatrophy of the brain before treatment is instituted. In the few cases of this type that have been treated no untoward results have occurred. Even the hair has not been destroyed.

Isodose curves for the Chaoul roentgen therapy unit have been persented in previous papers with other physical data.[1,6,7,8,10] Quimby and Focht have reported isodose data on the Philips unit.[3,9] The depth dose of these radiations parallels quite closely that of radium (Fig. 9).

We believe contact therapy offers the following advantages over topical radium: (1) there is danger to the operator in the handling of radium over a period of many years in the preparation and application of plaques and molds; (2) application of Chaoul therapy requires a much shorter

period of time than does radium; (3) the distribution of the radiation from the Chaoul unit and a well prepared radium plaque are about the same; (4) there is much less difficulty in holding the patient quiet for the short time required for the close distance roentgen therapy; there is less difficulty in treating certain areas with the Chaoul and the Philips therapy units such as those occurring on the lips, eyelids, scalp, vagina, etc.; (5) the skin end-results seem

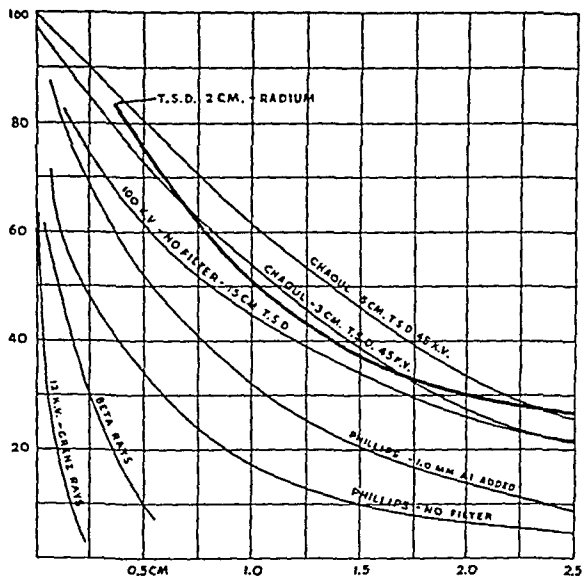


Fig. 9. Absorption curves for the qualities of radiation which are employed. The similarity of radium and contact roentgen therapy is illustrated.

better with roentgen radiation than with radium.

If the lesion is small and is located either around the eye, the lips or the nose, we prefer to use the Philips unit because it is easier to protect the eye, the eyebrow, and the eyelashes because of the greater latitude in dosage output per minute and the adaptability and sizes of the available cones. We use the Philips unit in certain other areas such as the labia where it seems more adaptable. In every other situation we prefer to use the Chaoul apparatus. The number of portals used depends upon the size of the lesion and its shape. The skin-target distance depends upon the depth of the lesion. In the port-wine stains, we would prefer to use the 1.9 cm. distance available with the Philips unit. In the deeper or thicker lesions 3 to 5 cm. skin-target distance is used with the Chaoul unit. In certain instances where the lesion is particularly large and bulky we employ intermediate voltage 75 to 135 kv. Most of the small and deep-seated hemangiomas are treated with radon after the skin discolora-

Kv.	*Added Filtration*	*Half-Value Layer*
44 (Philips)	None	0.3 mm. Al
44 (Philips)	2.5 mm. Al	1.4 mm. Al
45 (Chaoul)	None*	2.4 mm. Al
75	None**	0.6 mm. Al
75	1 mm. Al	1.7 mm. Al
75	2 mm. Al	2.3 mm. Al
75	3 mm. Al	2.5 mm. Al
100	None**	0.8 mm. Al
100	1 mm. Al	2.2 mm. Al
100	2 mm. Al	2.8 mm. Al
100	3 mm. Al	3.1 mm. Al
135	None**	1.2 mm. Al
135	1 mm. Al	2.5 mm. Al
135	2 mm. Al	4.0 mm. Al
135	3 mm. Al	4.6 mm. Al
135	5 mm. Al	5.0 mm. Al†
135	1 mm. Al plus 0.25 mm. Cu	9.0 mm. Al†

* Inherent filtration 0.2 mm. nickel.
** Inherent filtration about 0.2 mm. Al.
† Estimated values.

Fig. 10. Illustrating the quality of the types of radiation employed.

tion has been removed by roentgen therapy. With intermediate voltage we use 1 to 3 mm. aluminum filtration with half-value layer of 2.4 to 4.6 mm. Al; the filtration of the radiation with the Philips and Chaoul units ranges from unfiltered to 0.2 mm. nickel. The half-value layer of the radiation is 2.4 mm. aluminum[7] with the Chaoul apparatus and 0.3 mm. aluminum with the Philips unit at contact[9] (Fig. 10).

In preparing the patient for treatment he is restrained by wrapping securely with a small sheet (Fig. 11). Sand bags are useful in the younger children and will often serve as adequate restraint for the lower extremity. The area being treated is held by the radiologist or his assistant (properly



FIG. 11. Steps employed in wrapping the infant in order to restrain it during treatment. The radiologist or his assistant, adequately protected, firmly holds the area to be treated against the treatment cone. Sand bags are frequently used and the infant's parents are asked to help.

protected) and the part is held firmly against the treatment cone (pressure and counterpressure (Fig. 11). Additional restraint is furnished by the parent and this is particularly useful in older children. When a relatively large treatment cone is used we have found it helpful to *cover the end of the cone with scotch tape* to press the central portion of the lesion flat to the rest of the lesion. Otherwise, in very small lesions, the central portion may extend up into the treatment cone where it will get considerably more treatment because distances of a few millimeters are quite important. The lesion is then given 200 to 400 roentgens (as measured in air) through as

many portals as are required to cover it. It is not necessary that these portals overlap. If the portals approach each other as closely as 1 to 2 mm. the effect is adequate

are required and usually less than 1,500 r is given. Actually 75 per cent of our patients treated with Chaoul therapy only received less than 1,250 r, and 95 per cent received

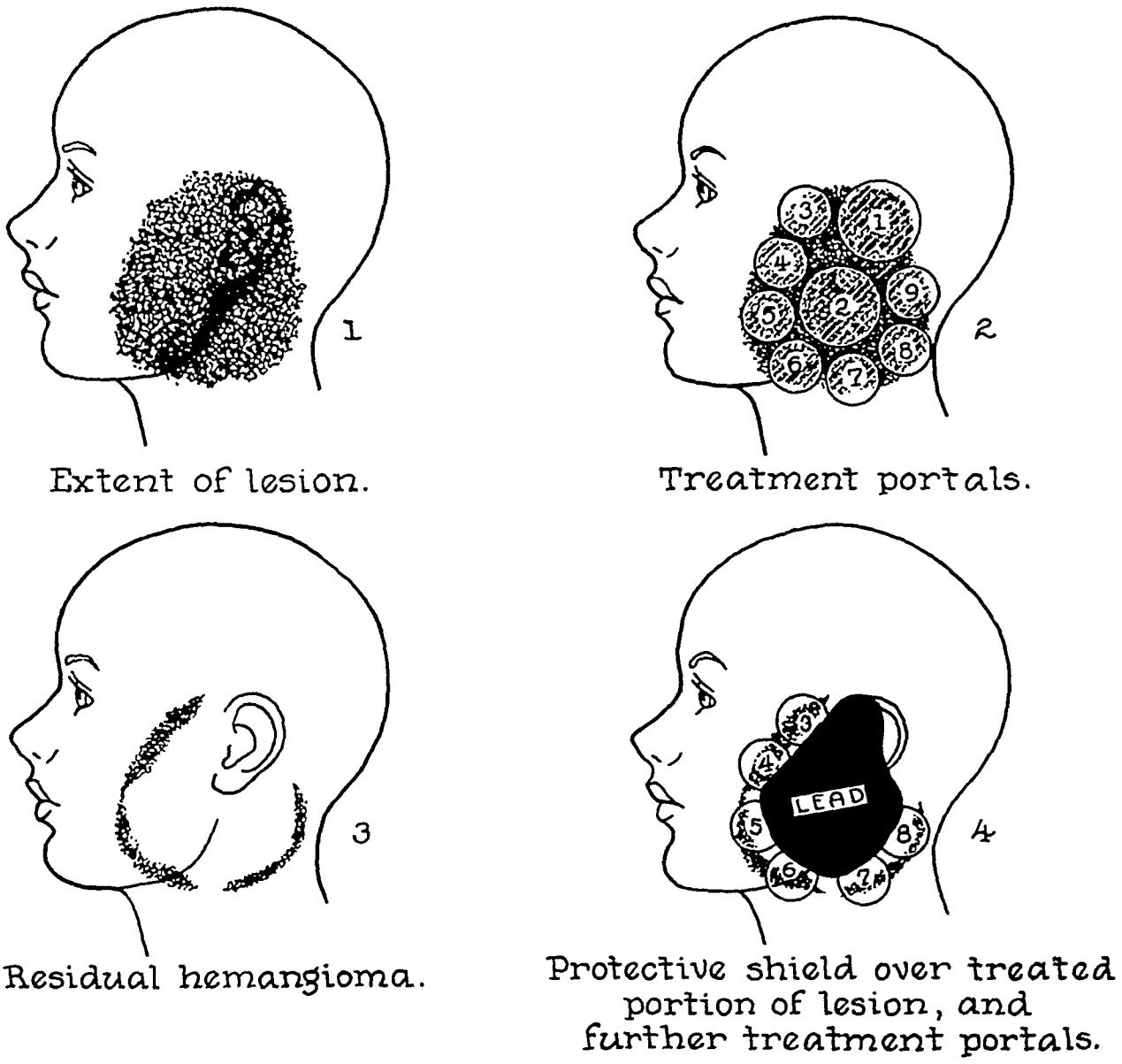


Fig. 12. Showing plan of treatment through multiple portals to a large lesion on the left cheek. It is not necessary that the portals overlap.

(Fig. 12). The patient is seen at intervals of four to six weeks. If no trouble is anticipated (such as possibility of sloughing, etc.) and the patient lives at a considerable distance, 400 r or rarely even more, may be given and the patient seen in three months. Usually three to seven treatments (visits) less than 1,750 r, the treatment time extending over a period of eighteen months.

In treating lesions on the face or other parts of the body where a normal appearing skin is desired, the dosage should be small and given very slowly. If large doses (500 r) are employed the skin effects will simulate

those of a faint vaccination scar. Lesions on parts of the body that are not exposed are treated enough to stop their growth. Under such circumstances, one to three treatments as a rule, are all that are necessary.

The more deeply situated portions of the hemangioma are treated with implantation of radon seeds of 0.1 to 0.5 mc. strength. We prefer to use small seeds implanted through multiple punctures. This technique will prevent migration of the seeds resulting in faulty distribution due to the "massage effect" often seen when all seeds are implanted through a single opening in a movable part such as the cheek or eyelid. For a lesion 1 cm. in diameter usually one seed 0.25 to 0.5 mg. in strength, will be implanted. If such a dosage does not produce an adequate response another seed may be implanted at a later date. We prefer to err on the side of too little treatment rather than too much. One thousand gamma roentgens delivered to the lesion is usually adequate.

In general, all lesions respond well if treated early. In some small bluish-red lesions, when it is presumed that the large venous elements are in preponderance, the family is advised that it will take a longer time to obtain a good result.

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COLLOIDAL LEAD ORTHOPHOSPHATE ASSOCIATED WITH DEEP ROENTGEN THERAPY IN BONE METASTASES FROM CANCER OF THE BREAST*†

By LAWRENCE REYNOLDS, M.D., T. LEUCUTIA, M.D., JAMES C. COOK, M.D., *and* KENNETH E. CORRIGAN, PH.D.

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DETROIT, MICHIGAN

FOR the past forty-five years repeated attempts have been made to use metallic substances for the treatment of cancer. Colloidal solutions of gold, copper, silver, bismuth, arsenic, sulphur, selenium and a variety of other elements or their compounds have been tried in turn, only to be discarded because of the indifferent success obtained by their use.[14,31,42,43] During the time of World War I, Bell,[6–11] after noting the rather slow rate of growth of cancer in lead workers, and based on the long known fact that lead causes abortion in pregnant women, carried out a series of experiments with this substance in growing plants and animals.

Bell used metallic lead which he suspended in a number of rather imperfect colloidal solutions. As he states, the whole object of the colloidal preparation was to deliver the lead to the highest bidder, as it were, among the body tissues without producing too many deleterious effects generally. Whereas a dose of little more than 0.2 gram of soluble lead was considered fatal when given in a single dose, with the suspended solutions it was possible to give 0.6 gram in seven or eight doses during a period of four months and have no serious consequences develop. The preparation of a suitable colloid, however, continued to represent a major problem. In the later phase of the work Bell used an electrical suspension of the metallic lead in an aqueous medium with a small amount of gelatin and calcium chloride, but even so the poor keeping qualities of the solution prevented a more general use of this form of chemotherapy. Bell himself repeatedly emphasized that the method is difficult and to some extent dangerous and that it can only be safely employed by those who have proper laboratory facilities at their immediate disposal.

Concerning the biologic effect, Bell found that the metallic lead has at least two attributes: (1) it has the power to arrest cell growth in general; (2) it has a certain special affinity for the chorionic epithelium and the malignant cells. The general arrest of cell growth was observed experimentally in all young plants and animals under investigation. The affinity for the chorionic epithelium manifested itself in the form of coagulation necrosis leading to abortion. The chemotherapeutic index of this effect was estimated as being approximately two. Under favorable circumstances a similar necrosis induced by the metallic lead was observed also in the cancer cells, although the chemotherapeutic index here was somewhat lower.

In 1926 Bell published the clinical results obtained in the treatment of a series of 200 cases of cancer. He arrived at the conclusion that all types of malignant neoplasms are probably amenable to the beneficial influence of lead, provided the metal can reach the tumor cells in sufficient quantities. Adjuvant surgical and radiation measures were considered to be of great aid in suitable circumstances. Finally, he anticipated that the effects of irradiation would be augmented by the previous use of lead.

* Presented at the Forty-eighth Annual Meeting, American Roentgen Ray Society, Atlantic City, N. J., Sept. 16–19, 1947.

† Supported in part by a grant from the American Cancer Society, Committee on Growth, through the National Research Council.

The observations made by Bell were borne out to a certain extent by Wood,[43] who also experimented with colloidal solutions of selenium, sulphur, silver and copper. Wood noted that the effect of lead on the tumor is characterized by intense congestion, thrombi formation in the capillaries twenty-four hours later, necrosis and finally absorption and shrinkage of the tumor. In using lead combined with deep roentgen therapy he found that the partial poisoning of the cancer cells by the metal and the injury produced by the roentgen rays add up, leading to an enhanced therapeutic effect.

Following this report of Wood and impressed by the investigations of Bell, Ullmann[38] of Santa Barbara, California, decided that the method showed sufficient value to warrant a thorough trial. Because of the instability and the great variation in the toxicity of the colloid suspension of the metallic lead which greatly limited its clinical usefulness, Ullmann's main interest was to secure a more suitable lead preparation. Bischoff, Blatherwick and their coworkers[12,13] after several unsuccessful attempts with the metallic lead, suggested that lead orthophosphate, $Pb_3(PO_4)_2$, be used. This salt is stable in neutral solutions and therefore can be kept unaltered much longer. In the presence of only slight acidity it is changed to the acid phosphate, Pb HPO_4, which is a hundred times more soluble. The theory was advanced that because of this property and since malignant neoplasms contain a certain amount of lactic acid, the tumor cells would be affected as by the metallic preparation but without the severe general toxic injury to the patient.

In subsequent publications[39–41] Ullmann described in detail the immediate and late reactions observed following the administration of colloidal lead orthophosphate confirming beyond doubt that this substance is much less toxic to the organism than the colloidal metallic lead or its other salts. He also determined that the maximum benefit was obtained when the lead was combined with roentgen or radium therapy. An average dose of 80 milligrams of colloidal lead orthophosphate was given intravenously once a week, reaching a total of 400 milligrams and the irradiation was begun when from 200 to 300 milligrams had been injected. After four to six weeks the treatment was repeated until a total dose of from 500 to 600 milligrams was administered. If signs of lead poisoning appeared, 2 grams of calcium lactate in 1 quart of milk were given every twenty-four hours.

The introduction by Ullmann, and Bischoff and Blatherwick of the rather stable and decidedly less toxic colloidal lead orthophosphate has led to a number of clinical investigations. The majority of workers concentrated their attention on the use of lead as the sole therapeutic agent, chiefly in advanced cases of cancer which could not be treated by other means. It was repeatedly demonstrated that lead concentrates more readily in cancer tissue than in the surrounding normal tissue.[4,10,11,25,30,32,43] In a case of periosteal sarcoma studied by Bell[10] the tumor contained 12 parts per million of lead and the nearby normal bone only 1 part per million of lead. Osterberg and his associates[32] found the concentration of lead in the tumor greater than that in the normal tissue by four to five times. Nevertheless to produce notable clinical regression of the cancer it became invariably necessary to raise the dose of the colloidal lead administered to 400 milligrams or more. Several authors[3,4,5,19,32] insisted that the dose should be pressed to plumbism, with its symptoms of severe abdominal colic, pains in the arms and legs, anorexia, vomiting, loss of weight and more or less severe anemia. These symptoms were then combatted with various measures ordinarily used in chronic lead poisoning.[5,25] An acceleration of the elimination of the retained lead was also attempted by the administration of calcium mobilizing drugs and parathormone.

Other investigators used colloidal lead in conjunction with deep roentgen therapy or radium. Such a course was already

pursued by Stone and Craver[36] in 1927 by employing a suspension of metallic lead prepared by Woodard. Stone and Craver found that, if combined with irradiation, good improvements could be obtained with doses as small as 75 milligrams of colloidal lead given in a single dose. Their experience suggested that, especially in bone metastases from carcinoma of the breast, lead in conjunction with radium or roentgen therapy could cause regression sufficiently complete to account for greater palliation than was formerly possible. A similar situation was noted in advanced osteogenic sarcoma. A combination of intravenous colloidal lead orthophosphate and deep roentgen therapy was used in various types of cancer by Aub and Smithwick[3] and in a limited group of cases by Bargen, Horton and Osterberg,[4] and by others. Nearly always, the dose of the colloidal lead orthophosphate was increased to the point of intoxication.

An analysis of the final outcome in all these instances shows a rather disappointing picture. There is a unanimous opinion that colloidal lead alone, whether given in the metallic form or as orthophosphate, offers no cure for malignant neoplasms. When used in conjunction with surgery or radiation therapy in the advanced cases it seems to have some usefulness, but according to Bargen, Horton and Osterberg[4,32] lead intoxication is necessary to produce satisfactory results. On the other hand, Aub and Smithwick[3] believe that colloidal lead orthophosphate, even if given in very large doses and followed by deep roentgen therapy, is not only valueless but shortens the life expectancy by the severe symptoms of intoxication and the anemia it produces. Gould, Kullman and Shecket[19] who made a very detailed study of the effect of lead on the blood cells of cancer patients, likewise found that if progressive anemia once developed there was little likelihood of improvement after the lead treatment was stopped.

At Harper Hospital in Detroit colloidal lead orthophosphate obtained through the courtesy of Drs. Ullmann and Bischoff (and for the last few years supplied by the Crookes Laboratories of New York) has been used since 1928. The procedure employed, however, has been along somewhat different lines. Although in the beginning there was a tendency to use the method in all advanced cases of cancer, later, based on experimental investigations and clinical observations, its use was restricted to those instances in which the osseous skeleton was involved. The great majority of cases, by far, was represented by carcinoma of the breast with bone metastases. The present paper deals particularly with this group of cases.

It was already observed early that in chronic plumbism lead is stored mainly in the bone along with calcium phosphate in the form of lead orthophosphate,[2] or a similar highly insoluble salt. It thus seemed that the calcium and lead may have some similarity of metabolic behavior and that the deposition and mobilization of the two elements may also be similar. Furthermore, it appeared probable that the absorption and excretion of the colloidal lead injected for therapeutic purposes may be modified by the same agents that modify the absorption and excretion of the calcium, and in the same direction.[35]

Chemical analysis made by a number of investigators revealed that shortly after the intravenous injection of colloidal lead preparations, the largest amounts of lead were found in the spleen and liver, [13,17,20,21,24] and less frequently in the lungs.[38] The blood stream lost the lead rapidly[13,30,31] the excretion occurring mainly through the kidneys and all parts of the gastrointestinal tract. At this stage the osseous structures showed a relatively low concentration of the lead.

Throughout the first week, however, the lead deposited in the spleen, liver and lungs decreased rapidly[3] through excretion and through gradual migration to the skeleton (Fig. 1). Later the greatest part of the retained lead (from 39 to 100 per cent) was found in the bones and teeth, it being confined to the solid portion of the bone.

To further substantiate the affinity of the lead for the osseous system, a series of diffraction studies were carried out at Harper Hospital in rabbits. Doses of different amounts of colloidal lead orthophosphate were injected into rabbits and the animals killed at definite intervals. Various portions of the bone were then subjected to diffraction analysis and the results noted. It was found that the colloidal lead orthophosphate, which has a typical pattern, was deposited largely at the place of most active new cell growth where the metabolism was greatest, such as along the epiphyseal lines. It appeared that the lead did not enter directly into the permanent structure of the bone, but replaced the part normally played by the calcium in bone metabolism, for a limited time (Fig. 2). This interpretation finds additional support in the observations of Aub[1] who, in chronic lead poisoning, was able to increase the normal excretion of lead from two and a half to three times by the administration of mineral acids or ammonium chloride and sodium bicarbonate, and to nearly twice the normal by the administration of potassium iodide, thus proving that the calcium and lead metabolism are interrelated to a certain extent.

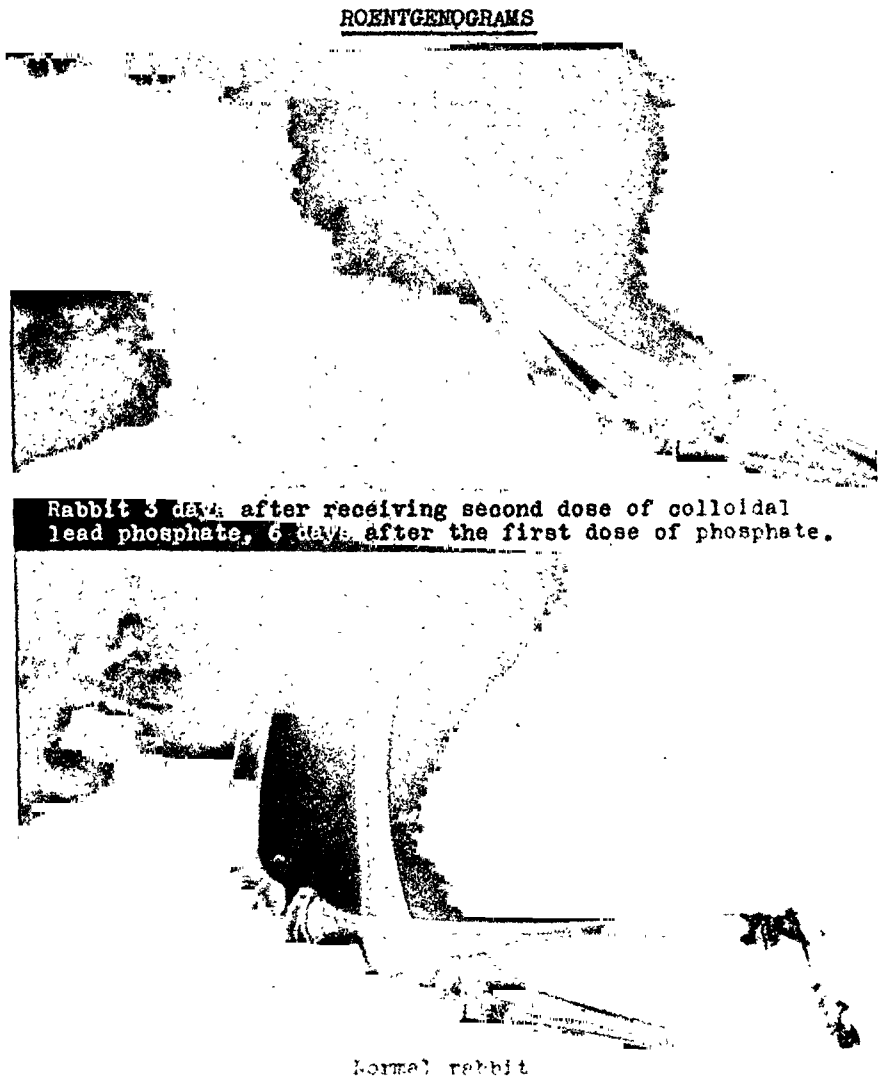


FIG. 1. Roentgenograms of the lower extremities of rabbits showing definite deposition of the lead along the epiphyseal lines.

Based on such considerations, it was assumed that the preliminary intravenous injection of colloidal lead orthophosphate would enhance the therapeutic efficacy of the roentgen therapy, especially in the malignant neoplasms with a more diffuse invasion of the osseous system. Three reasons were advanced for such an assumption. In the first place, as amply demonstrated above, the lead itself exercises a toxic action on the tumor cells; second, the roentgen rays produce a destructive effect in the well known manner; and third, the heavy lead ions deposited within the neoplastic tissue emit under the influence of the roentgen rays secondary electrons which add to the ionizing effect of the direct irradiation thus increasing to a certain extent the tumor dose. A good illustration of this latter effect is obtained by placing lead plates directly in contact with the patient's skin while administering supervoltage roentgen therapy as practiced, for example, in delineating the areas treated when the open field method is used. The secondary electrons emanating from the irradiated lead bombard the site of the closest contact of the lead plates with the skin. The reaction produced is superimposed on the skin erythema resulting from the direct action of the roentgen rays, with the consequence that a marked intensification of the redness is observed at the edges of the lead plates. This effect is not observed with deep roentgen therapy since apparently the range of the emitted secondary electrons is not long enough, but it is a very common occurrence

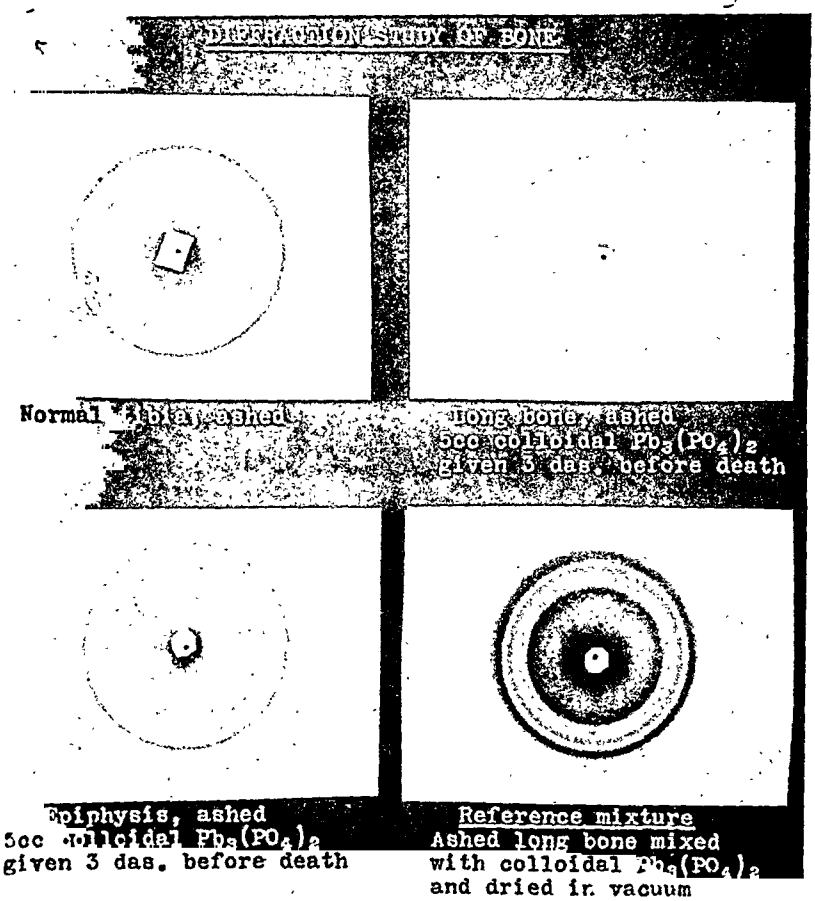


Fig. 2. It is demonstrated that that the colloidal $Pb_3(PO_4)_2$ is not deposited as such in the bone, but enters directly into the bone metabolism without destruction of the fundamental apatite structure. It probably replaces calcium or possibly magnesium in the structure.

with supervoltage roentgen therapy. Not infrequently the entire edge appears outlined, as if the erythema field were fenced in by a border of much deeper red (Fig. 3).*

The method employed has undergone, especially in the earlier days, several modifications. At first there was a tendency to give large total doses of lead producing a condition bordering on plumbism. However, since most of the patients were quite



FIG. 3. When protective lead plates are placed in direct contact with the skin while administering supervoltage roentgen therapy, the erythema field appears surrounded by a border of much deeper red, due to the added effect of the secondary electrons emanating from the lead.

ill to start with, the severe after-effects from the lead not infrequently added to rather than detracted from their discomfort. Similarly, a too intensive series of irradiation which was used in the beginning proved more of a disadvantage than an asset in the combination. The time interval between the injection of the lead and the starting of roentgen therapy had also to be carefully chosen. It was thought best to permit the greatest part of the circulating lead to be excreted and administer the irradiation during the deposition of the retained lead within the osseous system.

At the present time the procedure is more or less standardized. An average dose of 30 cc. of colloidal lead orthophosphate suspension containing 120 milligrams of lead is injected intravenously. Then three days later a series of deep roentgen therapy is given. As a rule, rays obtained with 200 kv., 1 mm. Cu, are used and full erythema doses are given per field in one seance. The number of fields selected for crossfiring depends on the physical measurements of the part of the body to be irradiated. Occasionally, in very heavy patients, supervoltage roentgen therapy is employed because of the greater depth dose. The entire series is completed in a period of from a few days to two weeks. A fractionation and protraction of the irradiation is rarely undertaken. Since not a few of the patients are quite ill and find it difficult to move about, hospitalization proves necessary in about 20–30 per cent of the cases. In the presence of pathologic fracture a suitable immobilization is provided for two to three months. The injection of the colloidal lead is repeated two months later and followed again within three to four days by a second series of deep roentgen therapy. The procedure is identical to that of the first series except for the fact that due to the marked improvement which has already occurred now only 10 per cent or less of the patients are hospitalized. This completes the course of treatment. Periodical check-up examinations are made thereafter at intervals of three months. When there is evidence that the carcinoma has spread to a new area, or that it has recurred, further lead, again in combination with irradiation, may be given at shorter or longer periods without fear of producing any general deleterious effect on the system. In one of the cases in our series a total of 1,200 milligrams of colloidal lead orthophosphate was injected

* While it has been shown many times (Quimby and Focht. Preliminary studies on dosage measurements with million volt roentgen rays. AM. J. ROENTGENOL. & RAD. THERAPY, 1941, *46*, 376–398) that this effect on the skin can be produced by almost any substance, the high atomic number of lead even in the weak concentration obtained makes it about eight times as efficient as a source of energetic photoelectrons as the average components of normal bone.

over a period of ten years, associated with twelve series of deep roentgen therapy with gradually reduced doses.

The administration of the colloidal lead in the amounts mentioned above carries practically no risk. The only contraindications are severe liver damage, nephritis and very marked anemia, with a hemoglobin below 30 per cent and a red corpuscle count below 2,000,000. In about 20 per cent of the cases the intravenous injection of the colloidal lead orthophosphate is followed within one to two hours by a chill and a temperature elevation up to 103° F. In another three to four hours the temperature drops to normal and no after-effects are observed. Occasionally, the chill and temperature elevation appear with a delay of twenty-four hours. Other complaints are slight nausea, anorexia and a feeling of tiredness. All of these symptoms, however, as so mild that the injection is nearly always given with the patient ambulatory and even the very ill patients are hospitalized only for the duration of the roentgen therapy series.

The complaints in conjunction with the invasion of the osseous skeleton by the malignant neoplasms begin to abate in about ten to fourteen days. In the great majority of the cases the pain, unless there is a pathologic fracture or a very wide dissemination, completely disappears within six to eight weeks. In three months there is a very solid reossification of the formerly destroyed areas of the bone permitting the resumption of limited activities. This alleviation of the distressing symptoms is the more remarkable since in an otherwise hopeless situation the efficacy and usefulness of most patients is greatly increased for the remainder of their expected life. Periodical roentgenograms show that the affected bone is often rendered so dense by the lead and roentgen therapy that it appears more compact than the normal bone

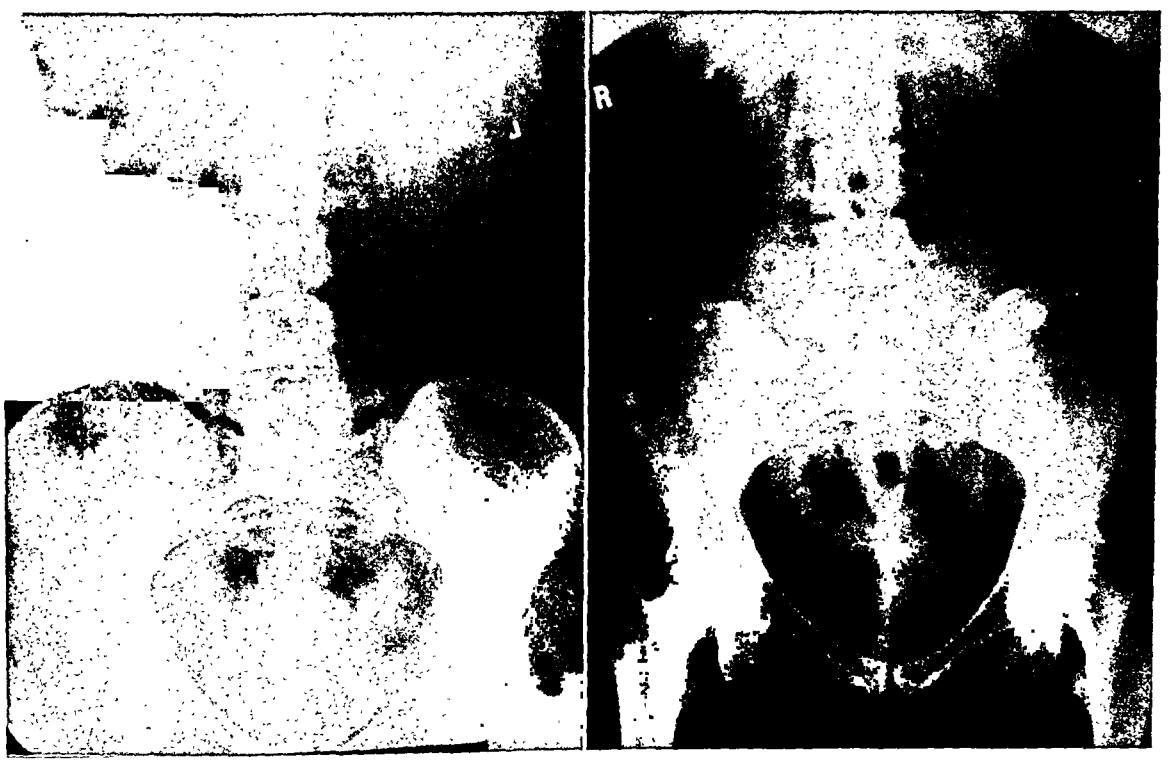


Fig. 4. *Left:* questionable areas of osseous rarefaction due to metastases from a primary carcinoma of the breast. *Right:* same, six months later, after two series of intravenous injection of colloidal $Pb_3(PO_4)_2$ associated with deep roentgen therapy, showing markedly increased opacities replacing the formerly destroyed areas.

(Fig. 5 and 10). At times, when at the initial examination there were questionable areas of rarefaction, following the completion of the treatment well demarcated dense nodes are visualized on the roentgenograms (Fig. 4), leaving no doubt about the correctness of the diagnosis.

A compilation of the final results shows that during the past twenty years 2,406 cases of carcinoma of the breast have been treated at Harper Hospital and that, of these, 355 have received a combination of intravenous colloidal lead orthophosphate and deep roentgen therapy following the development of bone metastases. It may be said that the symptomatic improvement in 95 per cent of the cases was very satisfactory. The average survival from the time of the institution of the treatment, however, amounted to only three years, the cancer in the interim having continued to extend to other regions and viscera until it became generalized. In 4 per cent the survival has been more than five years (Fig. 6, 7 and 11), the longest case in our records having lived ten years (Fig. 8, 9 and 12). There have been no permanent cures.

More recently, attempts were made to use some form of a radioactive colloidal lead orthophosphate for the intravenous injections, in the hope that the substance deposited in the osseous system might continue to act as a source of local radioactivity after the roentgen therapy series had been concluded. This would add to the three effects already mentioned a fourth effect, that of a prolonged internal radiation, the duration of which would depend on the half-life of the particular radioactive isotope inserted in the preparation and on the rate of excretion of the lead from the osseous system.

In a preliminary series of experiments "tracer" studies were made by using col-



FIG. 5. *Left:* metastasis to the head of the humerus from a primary carcinoma of the breast. *Right:* same three years later, after two series of colloidal $Pb_3(PO_4)_2$ and deep roentgen therapy. Patient died after four years.



FIG. 6. *Left:* very extensive metastases to the entire osseous skeleton, from a primary carcinoma of undetermined origin. *Right:* same, six years later, after several series of colloidal $Pb_3 (PO_4)_2$ and deep roentgen therapy showing remarkable bone regeneration. Patient died after eight years with general visceral metastases.



FIG. 7. Same case as in Figure 6, showing metastatic involvement of the cervical spine. *Left:* before treatment; *right:* six years after treatment.



FIG. 8. *Left:* extensive nodular metastases to the pleura with massive effusion following a primary carcinoma of the breast. *Right:* same, nine years later, showing complete fibrosis of the affected hemithorax as a result of three series of colloidal $Pb_3 (PO_4)_2$ and deep roentgen therapy.

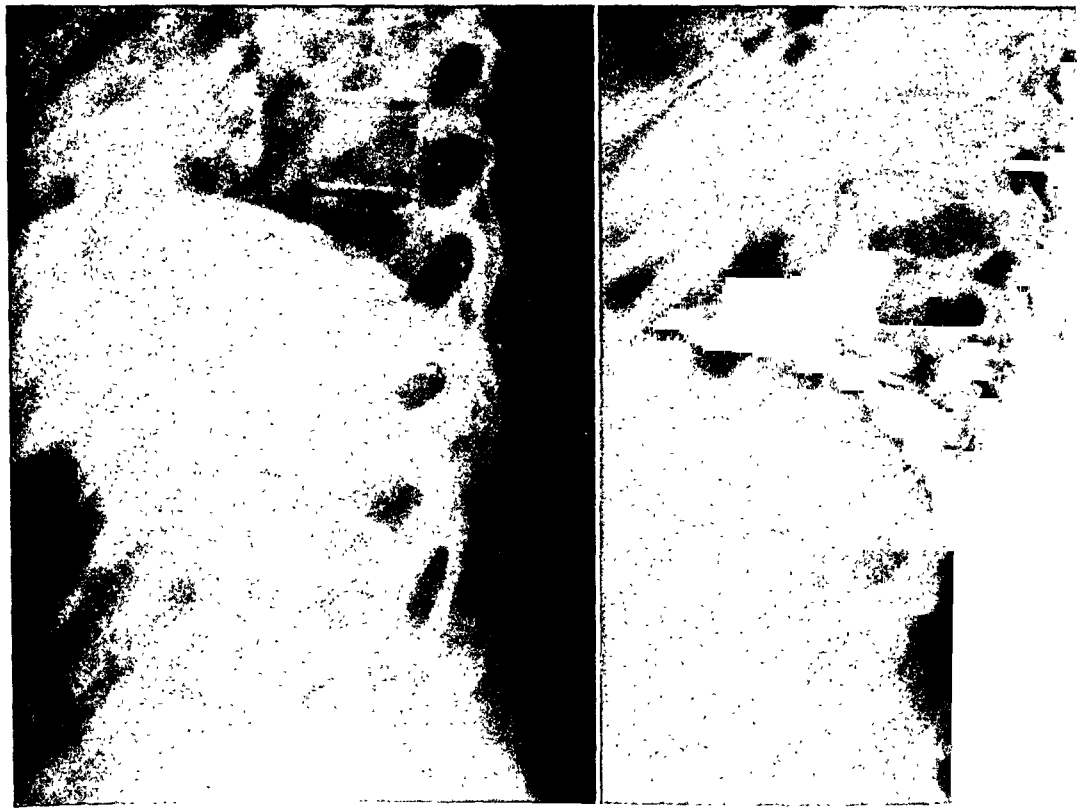


FIG. 9. Same case as in Figure 8. *Left:* seven years after the original treatment metastasis developed to the body of the twelfth dorsal vertebra. *Right:* following two additional series of colloidal $Pb_3(PO_4)_2$ and deep roentgen therapy good reossification occurred. Patient died after ten years with extension of the carcinoma to the brain.

loidal lead orthophosphate containing radioactive phosphorus. This material was prepared by Dr. Henrietta Hayden according to the following modification of the standard procedure:

Use 4.5 grams of gelatin dissolved in cold water, bring to boiling and add 1.25 grams of lead chloride. Then dissolve 1.3 grams of sodium phosphate (Na_3PO_4) in water. Add the required amount of radioactive phosphorus to give 0.1 millicurie of the phosphorus per 30 cc. of final solution, adding that to the lead chloride and gelatin which has previously been mixed. Then, while warm, add the sodium phosphate slowly. Dilute to a total volume of 250 cc. The entire procedure is done under sterile conditions. The solution is bottled, in this instance 30 cc. in each individual bottle. This is sterilized for one hour a day at 90° C. for four successive days.

The material so obtained was then injected into 7 three month old rabbits intravenously in varying amounts. The animals were followed closely for toxic manifestations, of which there were none, even though the dosage in some cases was five times that ordinarily administered to patients. The rabbits were sacrificed at intervals of nineteen, thirty-five, fifty-five, and sixty-eight days. Specimens were taken from the kidneys, liver, spleen, brain and epiphyseal areas and carefully studied for radioactivity. It was found that nineteen days following injection 8.78 per cent of the lead orthophosphate was in the liver, 1.54 per cent in the spleen and 0.05 per cent in the kidneys. At the end of thirty-five days 5.55 per cent was in the liver, 0.28 per cent in the spleen and no significant amount in the kidneys. After fifty-five days 0.05 per cent was found in the liver. Radioactivity remained present after sixty-eight days, but was insufficient for careful measurement. A count with the Geiger-Müller counter was considered significant only if it was at least twice the background.

From these findings it was concluded that the liver gives up its lead phosphate slowly compared to the spleen, which, however, contains a greater percentage for its volume (average weight of spleen being

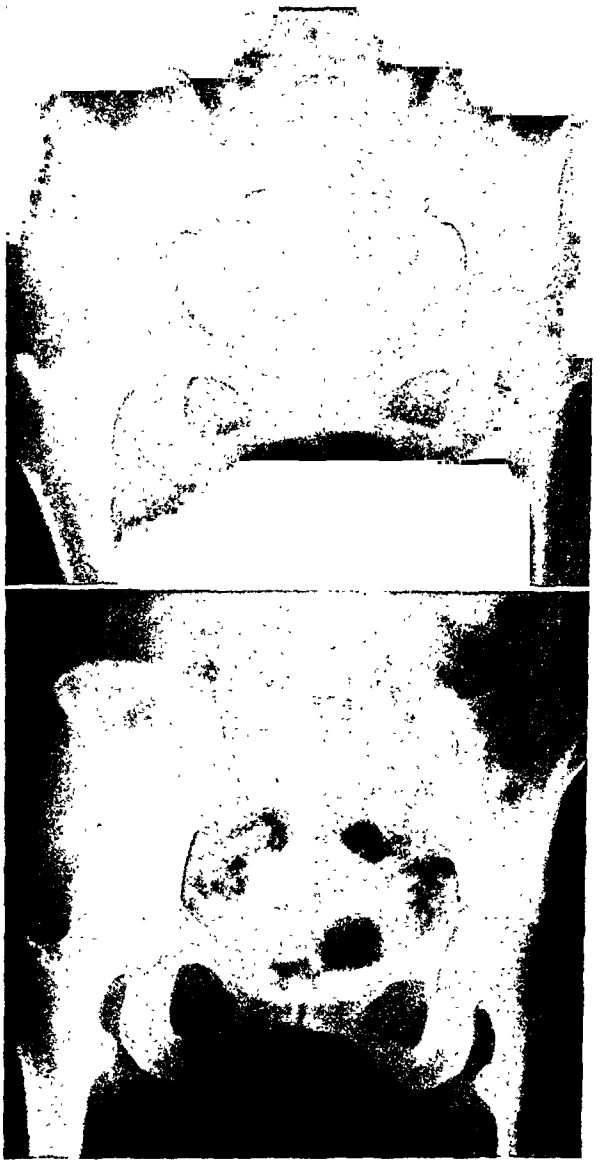


FIG. 10. *Upper:* massive destruction of the body of the ilium by metastasis from carcinoma of the breast. *Lower:* same, seven years later, after three series of colloidal $Pb_3(PO_4)_2$ and deep roentgen therapy, showing very compact reossification. The patient is alive after eight years.

2 grams and of liver 100 grams) in the first three weeks or more. The kidneys have little lead phosphate at any time after nineteen days. It was felt that inasmuch as no significant counts were obtained from the brain at any time, little free phosphate ion was present.

Roentgenograms made at regular intervals of the extremities of the animals indicated, as did the autopsy specimens, an increasing deposition of the lead phosphate

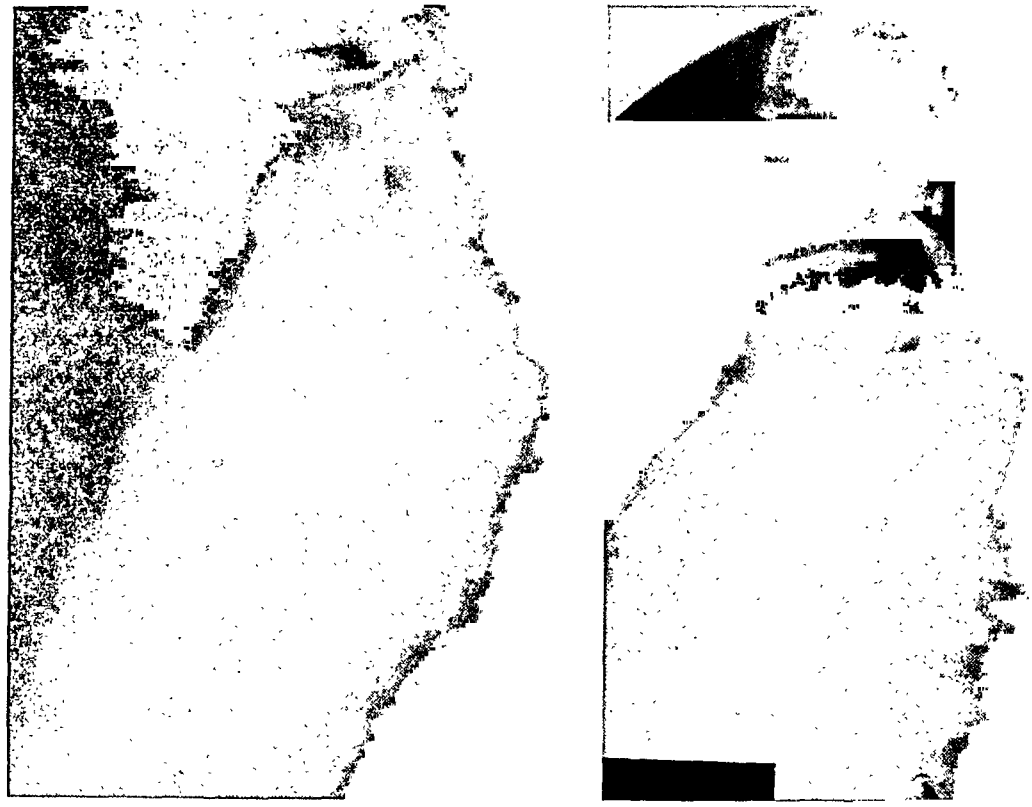


FIG. 11. *Left:* massive destruction with complete collapse of the body of the fifth lumbar vertebra from a malignancy of unknown origin. *Right:* same seven years later, after several series of $Pb_3(PO_4)_2$ and deep roentgen therapy. There is a good support of the collapsed vertebra and the patient is at the present time symptom-free.



FIG. 12. *Left:* metastatic lymphosarcoma of the upper tibia (proved by biopsy). *Right:* same five years later, showing complete regeneration of the bone. The patient is in excellent condition ten years after the onset of the lymphosarcoma, during which interval she received fifteen shorter or longer series of deep roentgen therapy and three injections of colloidal $Pb_3(PO_4)_2$ (for the bone metastasis).

in the epiphysis. These findings agree with those of Kehoe and Thamann[23] who found that the lead phosphate compounds are relatively inert and are excreted slowly but steadily. They, too, found that the lead was retained for a longer period in the liver than the spleen with eventual loss to the skeleton and excretion.

Following these preliminary experiments a preparation containing 100 microcuries of radioactive phosphorus (P^{32}) and 120 mg. of lead per 30 cc. of solution was made and injected intravenously into 6 patients, each of whom had neoplastic involvement of the bones. The primary lesions were represented by chordoma, carcinoma of the

prostate, carcinoma of the sigmoid, and carcinoma of the breast. Careful studies were carried out with the aid of the Geiger-Müller counter to determine the localization of the "tagged" phosphorus. Although in some of the patients the measurements were extended over a period of more than two weeks, no significant localization to the known tumor sites could be ascertained. This was rather surprising but it is possible that with a greater concentration of the "tagged" phosphorus or by "tagging" the lead rather than the phosphorus different results may be obtained. Obviously further exhaustive investigations are necessary.

SUMMARY

A detailed review of the literature shows that the colloidal lead orthophosphate, $Pb_3(PO_4)_2$, introduced by Ullmann and Bischoff, is considerably more stable and less toxic than the electric suspension of metallic lead used by Bell for the treatment of cancer.

Diffraction studies performed in rabbits at Harper Hospital confirmed the affinity of the lead for the osseous system, the largest deposition occurring along the epiphyseal lines and at the place of most active new cell growth. Apparently, the lead replaces for a limited time the part that calcium normally plays in bone metabolism.

The preliminary intravenous injection of colloidal lead orthophosphate in conjunction with roentgen therapy leads to a threefold effect in the malignant neoplastic invasion of the osseous system: (1) the lead has a certain toxic action in itself; (2) there is a direct destructive effect of the roentgen rays; and (3) the heavy lead atoms deposited within the tumor area emit, under the influence of the roentgen irradiation, ionizing secondary electrons which also act on the carcinoma cells.

The method has been used during the past twenty years in a series of 355 cases of bone metastases chiefly from carcinoma of the breast. In 95 per cent of the cases the immediate palliative effect was remarkable. The average survival amounted to three years. In 4 per cent the survival was more than five years. The case which survived longest lived ten years, but there were no permanent cures.

More recently attempts were made to use radioactive lead orthophosphate to add internal irradiation, if possible, to the above enumerated three-fold effect. In a series of preliminary experiments tracer studies were carried out in rabbits and some patients by injecting a specially prepared colloidal solution of the lead orthophosphate in which the phosphorus was "tagged." The results, in the main, substantiated the findings arrived at by chemical and roentgen diffraction analysis. However, further investigations, especially with "tagged" lead, are necessary, before worth while therapeutic efforts can be undertaken.

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THE SIMULTANEOUS DISAPPEARANCE OF TREATED AND UNTREATED TUMORS AFTER IRRADIATION

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IN SOME of our cases of multiple tumors, the treatment of one lesion was followed by the simultaneous disappearance of others. This has happened frequently enough to make the discussion of this topic of interest. Occasionally a tumor may disappear without treatment. The human body can, through some physical or chemical change, occasionally cause the disappearance of tumors. Radiation treatment of one lesion starts this natural process or enhances it. The local irradiation effects carried by the blood and lymph stream to the untreated areas may cause them to disappear. This disappearance of untreated lesions, along with treated ones, can occur in benign conditions of the skin such as psoriasis, hemangiomas, and warts. Occasionally the metastases of malignant tumors disappear with the irradiation of the primary lesion.

In some of our cases of myelogenous and lymphatic leukemia, lymphosarcoma and Hodgkin's disease, the irradiation of the spleen, or one particular group of glands causes the distal involved glands to disappear. At times in Hodgkin's disease, the fever, the skin eruption and itch disappear in twenty-four to forty-eight hours after the local treatment of the spleen.

Recently a patient in whom a malignant melanoma had been incompletely removed from her lower leg was sent to our clinic for irradiation. On admission she had extensive metastases to the groin and hundreds of little implants along the entire extremity. Roentgen therapy was given to the groin more as a gesture than anything else for these lesions are extremely radioresistant. About eight weeks later, it was a great surprise to see that not only had the groin metastases disappeared but also the leg metastases.

Irradiation may stimulate the natural reparative processes, and in some cases this is enough for a cure. The cure of some malignant tumors after an attack of erysipelas, relapsing fever, or by the administration of Coley's toxin, may be helping nature in a similar way.

One of our patients with proved Hodgkin's disease had complete disappearance of enlarged axillary and inguinal glands and a large mass in the epigastrium after a reaction as the result of a transfusion. Peculiarly he did not have a temperature reaction but rather a severe eczema involving both the skin and mucous membrane. We had had reactions from transfusions for several weeks at this time, the reactions starting when a batch of transfusion bottles came in containing sodium citrate 1.33 grams; dextrose C. P. anyhdrous 3 grams; citric acid U. S. P. 0.47 gram per 100 cc. There was 130 cc. of this solution in each bottle. These reactions had never occurred when we used our regular formula and they promptly disappeared when we changed over to it again. In this regular formula each 100 cc. of solution in the transfusion bottle contained dextrose C. P. anyhdrous 3.1 grams; sodium citrate U. S. P. XII 1.37 grams. There was 140 cc. of such solution in each bottle.

Was the citric acid the cause of the transfusion reaction? It was the reaction that caused the Hodgkin's lesions to disappear, and not the citric acid itself. The body manufactured some substance during the reaction which was injurious to the Hodgkin's granuloma. Possibly rapidly growing tissues cannot stand such sudden, shocking, destructive reactions as can normal tissues.

There are reported in the literature at least four hundred hopeless cases of malignant new growths in which cures resulted

after such inadequate procedures as a biopsy, an incomplete operation, after some secondary infection, or some unexplained fever.

Sussman[4] mentions the disappearance of lung metastases in 3 patients after the removal of only the primary lesion. One was operated on for a suprarenal tumor and is alive twelve years after the operation, one had a Wilms' tumor removed and is alive two years after the operation, and the last one was operated on for a hypernephroma and is alive three years after the operation.

All of us have seen cases in which metastases have remained the same size for years, the patient finally dying of some other disesae. Recently a patient died of heart disease in whom a breast amputation was done fifteen years before for a rapidly growing tumor. At death no recurrence was found about the breast scar but hundreds of metastases imbedded in fibrous tissue and calcification were found in the pleura and adjacent parts of the lung. Here nature was able to retard metastatic growth and imbed the tumor tissue in connective tissue and cartilage.

The human body is constantly making substances to combat tumor cell growth. When only a few tumor cells invade the blood stream from a primary growth, these cells are quickly destroyed. They never have a chance to gain a new foothold. It has been observed that in experimental animals a tumor embolism must contain at least 50,000 cells in order for a metastasis to gain a foothold and survive. The natural reparative processes of the body can destroy a few hundred metastatic cells but not many thousands. Some organs of the body can handle them better than others. The internal secreting glands such as the thyroid, pancreas, and so forth, destroy them easier than the lung and metastases rarely occur in these organs.

In the urine of some experimental animals, in which new growths were being produced by carcinogenic substances, there was found a non-carcinogenic hydroxide product of the carcinogenic substance being used to produce the tumors.

In some cases the rate of tumor growth, and tumor destruction by the normal tissues remain the same. In our clinic a boy of about nineteen years of age has a proved osteogenic sarcoma of the rib which has remained the same size for at least ten years. At operation it was found that it would be impossible to remove the growth and nothing but a biopsy was done.

At times the explanation of distal reaction to local treatment is adequate, as in the cases of disappearance of metastases of breast carcinoma with the irradiation of actively functioning ovaries. Since ovarian secretion stimulates the growth of mammary glandular tissue, the removal of this stimulation deprives the metastases of their growth activity. The administration of testosterone in some cases causes the disappearance of metastatic breast carcinoma by depressing this ovarian activity. Since uterine fibroids are known to be due to hypersecretion of estrin, one can see how the decrease of this secretion by irradiation of the ovaries can stop the growth of this tumor. Also since a hypersecretion of the male gonad increases the growth of the prostate, it can be seen how methods of reducing this secretion can be of benefit in prostatic cancer and its metastases. There also seems to be some foundation for understanding the decrease of organic activity by the irradiation of the corresponding neural segment along the spinal cord. By so doing alterations in the nervous and arterial functions occur in these organs.[1]

A study of what local chemical and physical changes occur with irradiation and how many of these changes can be transmitted by the blood and lymph stream would be of value. The subject, however, is not so simple. In a cancer patient there are numerous blood and lymph changes. Some of these blood and lymph changes are secondary to the cancer growth, some may be primary and the cause of the

growth. Many of these changes may be nature's method of combatting the new growth.

A brief review of these various chemical and physical changes will be of value and possibly shed some light on how the body cures new growths and whether irradiation works in the same or a different way.

At first let us review briefly how a new growth differs from a normal one and how the new growth affects the blood stream and body fluids.

In a new growth there are microscopic, physical, colloidal, chemical, enzyme, protein, carbohydrate, and lipoid changes from normal.

The microscopic changes are well known. The tumor cells show features of anaplasia, loss of specific form and polarity, variation in size, multiform nuclei, atypical mitosis, and especially an increase in chromatin content of the nucleus. This increase in chromatin signifies an increased nutrition and increased powers of growth. There is an increase in the size of the nucleolus and there are changes in the number and sizes of the chromosomes.

The permeability of the cancer cell membrane is increased, and an increase in the water content of the cell occurs. Usually the more active the tumor, the greater the amount of water.

In malignant tumors there is a relative increase of potassium over calcium whereas in benign tumors the opposite is true. The inorganic salts of a cancer cell are decreased.

The extracts of cancer tissue have greater reducing powers than normal and this expresses itself in the blood serum, for the blood serum of cancer patients reduces methylene blue to a leuko base while the normal blood serum does not.

There is a change in the total protein and nitrogen contant of the new growth. While the total protein and nitrogen is less than normal certain fractions are greater. The globulin portion of the protein is relatively increased over the albumin. The globulin is 82 per cent of the total proteins instead of the normal 30 per cent. There is an increase in fibrinogen. The incoagulable proteins such as histones and protamines are increased. The amino acids necessary for life, such as lysin, cystine, and tryptophan are increased. These increased protein changes in the cancer cell manifest themselves in the blood and body fluids, and many tests have been developed for this increase, such as the Suranyi test, the anaphylaxis test, Botelho's test in which precipitation of globulin occurs with weak acids, and the photochemical test, in which precipitation of histones, protamines, and globulins occur with silver nitrate. The coagulation time is decreased.

Carbohydrate changes occur in a cancer cell. Cancer cells can burn sugar aerobically and anaerobically to lactic acid only. Normal cells can burn sugar down to carbohydrate and water. The cancer cell therefore is more acid than the normal one, and affects the blood this way also. The neutral red test has been developed to show this change.

The lipoid changes in a cancer cell are the most important. There is an increase in both cholesterol and lecithin, and this increase manifests itself in both the blood and the lymph stream. A great number of blood cancer tests probably is based upon the fact that the presence of increased cholesterol lowers the surface tension and causes flocculation and precipitation. The following tests are based upon this characteristic: miostagmin test, Shaw-Mackenzie test, Wiel-Braun test, Bozzo-Lombardi test, Kahn test, Freund-Kaminer test, Fry's flocculation test and eosin test.

It is probably also this increase in cholesterol which accounts for the increase in the water content of the cancer cell and its increase in permeability.

The enzyme contents of a cancer cell are changed. There is an increase in the protein digestive enzyme ereptase. The carbohydrate enzyme glutathione is present in greater amounts. The lipases present digest all fats with the exception of cholesterol.

This fact is worth remembering.

In a cancer patient these changes, caused by the growth and carried by the blood and lymph stream throughout the body, affect the normal physiological processes of other organs. In some, they increase the functions, in others they diminish them. They cause an increase in the size of the pituitary and the adrenal cortex. They cause a hypertrophy of the entire reticulo-

Cholesterol, when heated, will cause tumors in rabbits and mice. Cholesterol is closely related chemically to the coal-tar carcinogenic substances, which have produced in lower animals practically all the malignant growths known to man. It is closely related to male and female sex hormones, which under certain conditions have produced cancer, and also to ergosterol and vitamin D, which under actinic stimulation

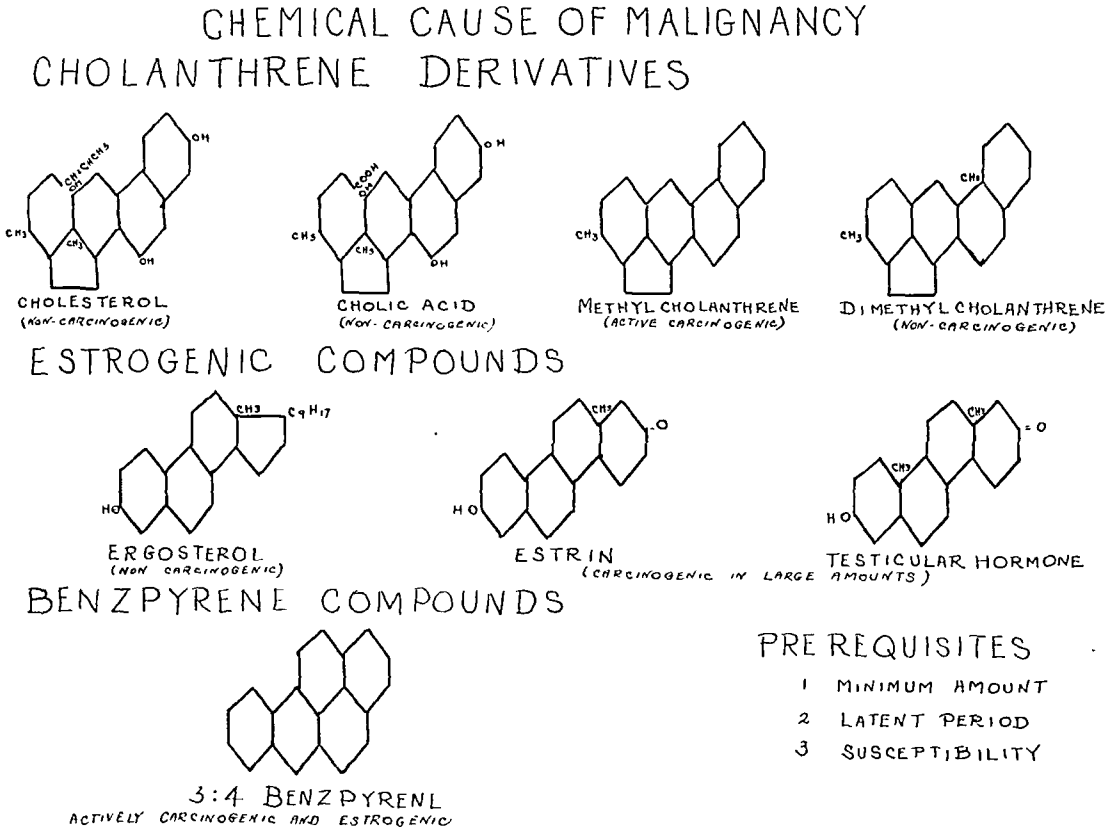


FIG. 1

endothelial system. The liver, the gastro-intestinal tract, the muscular and skeletal and hemopoietic system are depressed. This in part explains the loss of weight, anemia, cachexia, and debility in many cancer patients.

How many of these cancer cell and blood changes are primary, and how many are secondary to the growth, are not definitely known, but I believe that of all the changes, the cholesterol changes are the most closely associated with the cause of cancer, rather than secondary to it, for the following reasons:

might be responsible for carcinoma of the skin.

In Figure 1 is shown the close chemical relation of cholesterol, ergosterol, and the gonadal hormones, to the carcinogenic substances. In the production of experimental new growths in lower animals certain prerequisites are necessary: The carcinogenic substance used must be of sufficient amount; the time over which it is used must be long enough; and the animals in which it is used must be susceptible to it.

By certain chemical changes cholesterol, which is present in every cell of the body,

could be converted to carcinogenic substances. Irritation, inflammations, ulcerations, and so forth, over a long enough period in a patient whose tissues are susceptible, might cause this carcinogenic transformation of cholesterol. Mild cholesterol changes might cause hyperplasia and proliferation of cells, and greater cholesterol changes might produce the disorganization which occurs in carcinoma.

Also note how the addition of a CH_3 to the actively carcinogenic substance, methyl cholanthrene renders it non-carcinogenic (dimethyl cholanthrene). It is possible that in some similar way the body occasionally cures its own new growths. Possibly the future cure of carcinoma awaits some similar simple chemical change.

Irradiation also causes local changes, and these changes manifest themselves distally by means of the blood and lymph stream. The local changes seen microscopically are an increase in the size of the cells and their nuclei. The greater the irradiation, the greater the swelling. The more abundant the circulation in the neighborhood of the new growth, the greater the extent of this cellular swelling. The cells swell because irradiation increases the cell permeability and the osmotic pressure within the cells, thus water enters the cell and the nucleus. The permeability of the cell membrane is unidirectional. Water can go in but waste products of metabolism cannot get out, unless the cell dies and breaks up.

The irradiation causes physical and chemical changes in the cell by means of ionization. The atoms of the cell absorb a quantum of radiation and lose electrons in the form of corpuscular rays. The ionization thus produced modifies the electrical charge of the colloids and crystalloids in the cells and tissue fluids.

The colloids in the cells have negative and positive charges of electricity. They are important in the function of protoplasm, because of their ability to alter surface tension, absorption, and catalytic properties. The consistency of protoplasm, whether fluid or gelatinous, the quantity of water imbibed, depends upon the colloids. Many of the larger molecules and loidal particles are broken into smaller ones by ionization, thus increasing the osmotic pressure.

The properties of colloids are greatly influenced by physical, electrical and chemical conditions of the medium in which the colloid is suspended. The medium in which protein and lipoid colloids function is a saline one. Ions of these saline or crystalloid molecules, in the metabolism of cells, pass in and out of cells, and by these ions the alkalinity of the cell is maintained, oxygen and food are brought to the cell, carbon dioxide and waste materials are removed. Electrical changes that occur in muscle, nerve tissue, etc., also depend upon the ionic action of crystalloid substances. As a result of ionization caused by irradiation, the normal electrical charges of these saline ions are changed, and this along with the altered colloids disturbs the functions of the cell, its metabolism, and life.

Many colloids and crystalloids have no electrical charge, and need none for proper function. The ionization of these produces improper metabolism, and the change may be sufficient to injure or destroy the cells.

The chemical changes which follow ionization are many. Changes occur in the minerals, the proteins, the carbohydrates, the lipoids and, the enzymes of the cells. Oxygen can be converted into ozone, metals are oxidized, some salts are decomposed, and a change occurs in manganese. Oxyhemoglobin is often changed into methemoglobin. There is an increase in the coagulation of globulin. Organic matter decomposes, fatty tissue becomes harder, and cholesterol and its salts are made to disappear from solution. This seems especially important in view of the fact that the principal cause of cancer may be due to activated products of cholesterol. The various cell enzymes such as trypsin, pepsin, and invertase, are inactivated by irradiation, and sucrose may be inverted.

These changes caused by ionization in the cells, the tissue fluids and the intracel-

lular medium are probably carried by the blood and lymph to all parts of the body. That irradiation produces a distal effect is well known. These patients complain of dizziness, weakness, sleepiness, loss of appetite, nausea and vomiting. Radiation sickness is probably due in part to the physical and chemical changes of ionization and in part to the products of disintegration of sensitive cells which are circulated throughout the body by the blood and lymph stream. Some say that the blood of patients treated with radiation contains a substance which is toxic to plant test objects and that this is the cause of radiation reactions. Others believe that it is due to a decrease in the amount of blood cholesterol as a result of ionization and that this decrease in cholesterol causes radiation sickness through irritation of the vagus. Some claim that radiation sickness is due to a decrease in blood sugar and vitamin B_1. Giving these patients increased sugar, liver extracts, and vitamin B_1 does improve their radiation sickness. Upon the basis that local ionization produces a damaging effect to the entire reticulo-endothelial system, congo red has been given to prevent this radiation damage. Lofstrom and Nurnberger[3] think that radiation reaction is due to histamine-like substances. These substances have been found in fresh blood samples after irradiation. They give benadryl in 50 mg. doses three to four times a day for several days, with good results.

At any rate, whatever be the cause of radiation sickness, there are definite distal reactions to local irradiation. The local physical and chemical changes due to irradiation affect the blood stream and then the distal lesions. When these distal lesions are radiosensitive, they are deleteriously affected. It is most often the radiosensitive lesions, such as the lymphosarcomas, the leukemias, Hodgkin's disease, hemangiomas and warts which are affected.

To determine which specific change produces the disappearance of distal lesions will require a great deal of research. In a great many ways the finger points toward some change in both the amount and the chemical character of cholesterol. As has already been shown, a slightly chemical changed cholesterol seems responsible for new growths. Cholesterol is increased in the cancer cell. Cholesterol is closely allied chemically to carcinogenic substances. Irradiation causes cholesterol to disappear from solution. It causes blood cholesterol to fall. There may be a change in the growth stimulating character of cholesterol as well as in the amount, and this probably is not determined by the usual method of cholesterol analysis. This change in cholesterol both locally and in the blood stream may deprive the primary lesion and its metastases of their growth stimulating element and in this way cause their disappearance. These cholesterol changes may be produced by causes other than irradiation. The low cholesterol level in starvation has caused certain experimental tumors to disappear. New growths will occasionally disappear without irradiation or any other form of treatment. In these cases, the body may not only lower the blood cholesterol, but also change it chemically so that it is not growth stimulating.

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THE DIAGNOSIS OF SUPRASELLAR TUMORS BY PNEUMOENCEPHALOGRAPHY*

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THE localization of intracranial tumors has always constituted a fascinating problem from the standpoint of neurological diagnosis. Great advances have been made in this regard as a result of a more accurate determination of the diagnostic significance of symptoms and signs with reference to cerebral localization. Nevertheless there still often remains the problem of accurately establishing the nature of the lesion even though the localization is made evident by the symptoms and signs. The suprasellar region has long been an area in which the conclusive establishment or exclusion of a tumor was associated with uncertainty and frequent errors in diagnosis. The fact has been recognized that relatively large neoplasms could exist in the suprasellar region without producing definite localizing clinical manifestations at a time when neurosurgical intervention would be most beneficial to the patient.

Efforts to cope with the diagnostic problem presented by a suprasellar expanding lesion have been made and have contributed to a partial solution of this problem. Foster Kennedy[5] called attention to the syndrome bearing his name in 1911. At that time he considered it to be "an exact diagnostic sign" of tumors or abscesses in the subfrontal region, but he later broadened the concept of this syndrome to include aneurysms[6] in the same region. The syndrome as originally described consists of the presence of a central scotoma and primary optic atrophy an the side of the lesion with papilledema on the opposite side. When present, this syndrome has been diagnostically valuable but it does not occur in more than a relatively small percentage of tumors situated in the suprasellar region. Even when it does occur, a recent report by Yaskin and Schlezinger[13] has shown that the syndrome cannot be considered as pathognomonic of neoplasms but may be a result of arteriosclerotic compression of the optic nerves.

Another contribution to the early diagnosis of tumors in the suprasellar region has been the emphasis placed upon the visual field defects which may occur in such cases. Most helpful in this regard is the characteristic bitemporal hemianopic visual field defect but this is by no means a constant manifestation. Not uncommonly the visual field defects are of a bizarre form in which both central and peripheral defects of an expanding sector type are observed. These have been described as constituting a prechiasmal syndrome and the significance of scotomatous field defects in the diagnosis of suprasellar meningiomas has been emphasized recently by Schlezinger, Alpers and Weiss.[10] Similarly, defects in the fields of vision in cases of suprasellar hypophyseal duct neoplasms have been investigated by Wagener and Love.[12] Although such visual field defects are an important consideration in the early diagnosis of suprasellar tumors and are present sooner or later in nearly all such cases, it must be realized that these visual field defects are not conclusive evidence of an expanding lesion but may also occur in such conditions as optochiasmatic arachnoiditis, multiple sclerosis, syphilitic optic atrophy, and encephalitis. The differential diagnosis has been difficult and neurosurgical intervention has often been delayed until such time as the patient's vision is irreparably damaged or a tumor has assumed such dimensions that its removal constitutes a threat to survival.

Several observers have explored the pos-

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sibility of contrast visualization with iodized oil as a means of detecting tumors in the suprasellar region. Balado and Pardal[2] described a method utilizing iodoventriculography, and reported filling defects in the

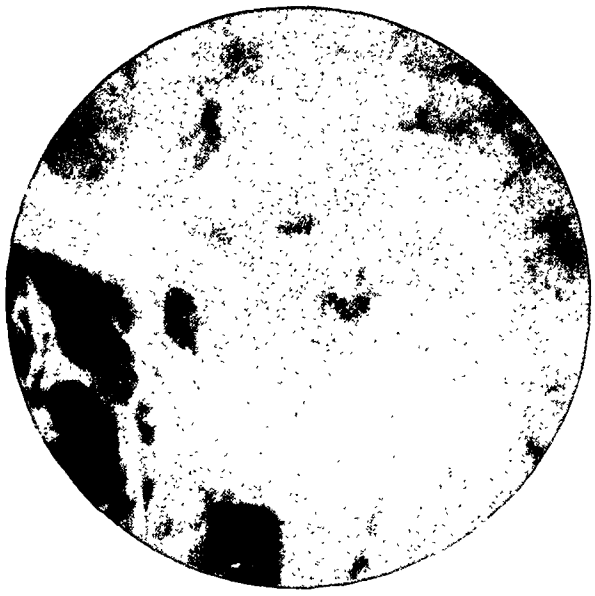


FIG. 1. Case 1, S. G. (J. H. No. GH1861), female, aged thirty-six. History of sudden awareness of complete amaurosis on the left followed over a period of eighteen months by frequent generalized headaches. Neuro-ophthalmologic examination disclosed pallor of both optic discs; amaurosis of the left eye and temporal hemianopia of the right eye. Laboratory data, including a spinal fluid examination, within normal limits. Roentgenogram of skull negative. Pneumoencephalogram normal except almost complete obliteration of the cisterna chiasmatis. Diagnosis: suprasellar meningioma, verified.

floor of the third ventricle. Subsequently, Carrillo[3] reported his results using a similar diagnostic procedure. Schüller[11] suggested the use of concentrated lipiodol for the purpose of cisternography. Since the use of iodized oil intracranially is hazardous, it is questionable whether these methods are deserving of routine clinical use.

Dyke and Davidoff[4] were the first to recognize the value of pneumoencephalography in the diagnosis of suprasellar tumors and they described the filling defects in the cisternae surrounding the optic chiasm. More recently Balado and Oribe[1] have reported similar cases investigated by means of pneumoencephalography in which visualization of the chiasmatic cistern and the floor of the third ventricle was said to have been improved by roentgenography with the head upside down.

In an attempt to determine whether a conclusive diagnosis of a tumor in the suprasellar region could be made early by means of routine pneumoencephalography, it was decided to review the pneumoencephalograms which were done in 5 patients who had a diagnosis of suprasellar neoplasm. This survey disclosed a striking alteration in the appearance of the cisterna chiasmatis, best described as obliteration,

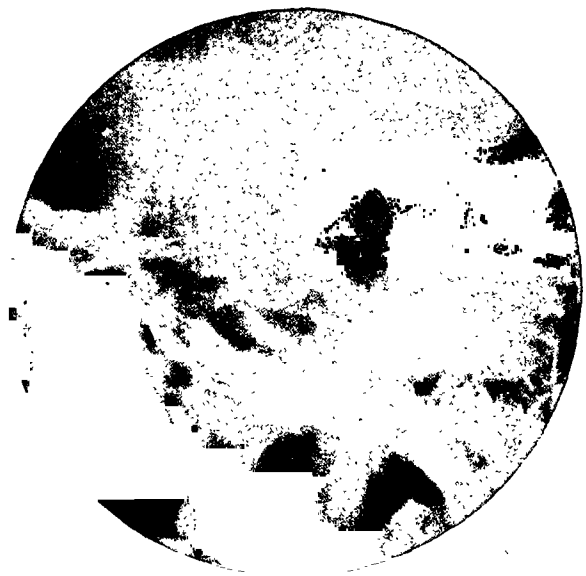


FIG. 2. Case II. B. D. (J. H. No. GH7059), female, aged sixteen. History of headaches for three years with periods of remission; vertigo for three months; impaired memory and blurring of vision for two months. Neuro-ophthalmologic examination showed temporal pallor of right optic disc, combined pallor and edema of left optic disc; peripheral and central visual field defects of both eyes. Laboratory data, including spinal fluid examination, within normal limits. Roentgenogram of skull negative. Pneumoencephalogram showed a sharply demarcated obliteration of the cisterna chiasmatis and an encroachment upon the floor of the third ventricle. Diagnosis: suprasellar meningioma, verified.

in 4 cases (Fig. 1, 2, 3 and 4) in which the existence of a meningioma in the suprasellar region has been verified by operation and in another case (Fig. 5) where the presence of a hypophyseal duct tumor is highly probable.

In order to fully appreciate the diagnostic significance of obliteration of the cisterna chiasmatis in the pneumoencephalogram, it is necessary to briefly review the anatomy of this area and to correlate it with the appearance in pneumoencephalography. Schaeffer[9] has clearly shown that the exact position of the cisterna chiasmatis depends upon the anatomical position of the optic chiasm which may vary considerably in its relationship to the tuberculum sellae. His classical investigation also established the fact that the optic chiasm in 91 per cent of instances occupies a position directly

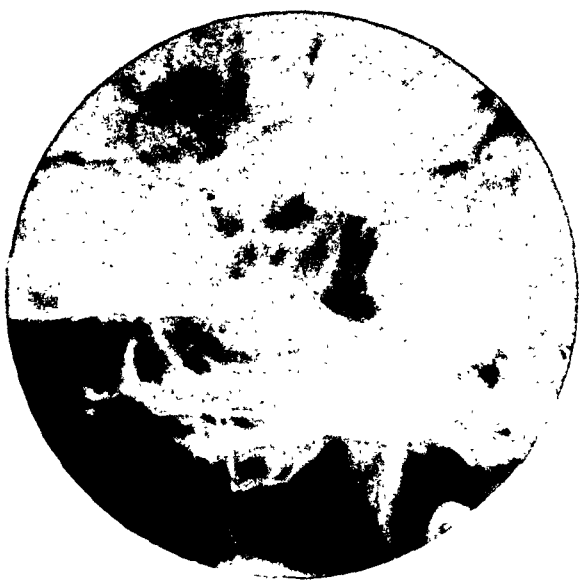


FIG. 3. Case III. C.W. (J.H. No. FH3327), female, aged twenty-three. History of increasing visual impairment of left eye associated with frontal headaches for three months and slight visual impairment of right eye for one month. Neuro-ophthalmologic examination showed slight pallor of left optic disc; inferior altitudinal visual field defect merging with a central scotoma on the left, and a central scotoma for color on the right. Laboratory data, including spinal fluid examination, within normal limits. Roentgenogram of skull negative. Pneumoencephalogram showed an obliteration of the cisterna chiasmatis. Diagnosis: suprasellar meningioma, verified.

above the diaphragma sellae while in another 4 per cent it is located above and posterior to the dorsum sellae. This anatomical fact permits one to consider the chiasmatic cisterna as including the basilar subarachnoid space above the sella turcica and overlying the diaphragma sellae. This

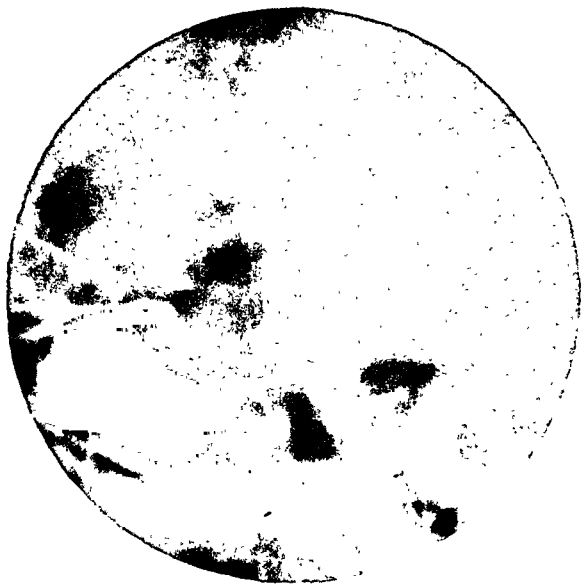


FIG. 4. Case IV. W. S. (J. H. No. HH13082), male, aged forty-four. History of impaired vision affecting the lateral half of the field of vision of the right eye for six weeks; impaired memory for about a year. Neuro-ophthalmologic examination showed pallor of both optic discs, more so on the right; slight proptosis of the right eye; temporal hemianopia of the right eye. Laboratory data within normal limits except for an increased spinal fluid protein of 130 milligrams. Roentgenogram of the skull negative. Pneumoencephalogram showed obliteration of the cisterna chiasmatis and a filling defect in the anterior portion of the floor of the third ventricle. Diagnosis: suprasellar meningioma, verified.

concept is in agreement with that expressed by Pancoast, Pendergrass and Schaeffer[7] who describe the cisterna chiasmatis as "located beneath and behind the chiasma —well portrayed as a rule just above the hypophysis." The cisterna chiasmatis communicates rostrally with the cisterna lamina terminalis and communicates caudally with the cisterna interpeduncularis.

A study of normal encephalograms with the anatomical definition of the cisterna chiasmatis as outlined above results in a 94 per cent visualization of this structure. This result was obtained in a control series of 150 consecutive pneumoencephalograms in which no lesion in the suprasellar region was suspected. It should be emphasized that for reliable visualization of the basal cisterns it is essential that there be adequate replacement of cerebrospinal

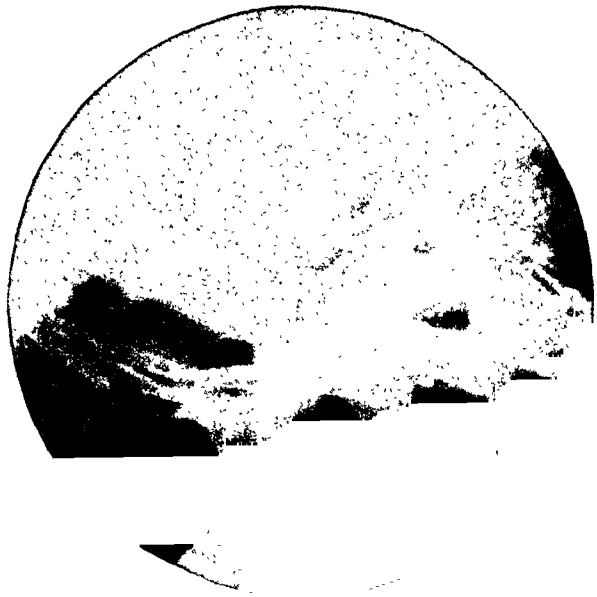


FIG. 5. Case v. J. G. (J. H. No. EH4554), male, aged nine. History of severe headaches for nine months and complete amaurosis for four months. Neuro-ophthalmologic examination revealed amaurosis and consecutive optic atrophy bilaterally; loss of pupillary reaction to light bilaterally; infantile habitus. Laboratory data, including spinal fluid examination, within normal limits. Roentgenogram of skull negative. Pneumoencephalogram showed complete obliteration of the cisterna chiasmatis with encroachment upon the cisterna interpeduncularis and cisterna pontis; upward and backward displacement of the third ventricle and anterior horns of the lateral ventricles. Diagnosis: suprasellar hypophyseal duct neoplasm, unverified.

fluid and that roentgenography be made in the erect posture. The size of the cisterna chiasmatis varies considerably (Fig. 6 and 7). Schaffer[9] reported an anatomic variation in depth from a potential space to a level of 10 millimeters.

Hypophyseal adenomas, hypophyseal duct neoplasms, and meningiomas are the tumors most commonly observed in the suprasellar region. Aneurysms of the internal carotid, anterior cerebral, and anterior communicating arteries are not infrequent. Gliomas of the optic chiasm are being reported in increasing number. Non-neoplastic lesions involving the primary visual pathways and, therefore, capable of producing a chiasmal or prechiasmal syndrome, include multiple sclerosis and retrobulbar optic neuritis. Optochiasmatic arachnoiditis (Fig. 8), as shown in a recent report by Pendergrass and Perryman,[8] is deserving of special attention in the differential diagnosis of suprasellar tumors since it is capable of obliterating the cisterna chiasmatis in pneumoencephalography and thus may not be distinguishable from a suprasellar tumor. However, the significance for the patient is more apparent than real since early diagnosis and neurosurgical treatment are desirable in both arachnoiditis and tumor cases.

Routine roentgen study of the skull will reveal quite variable findings in tumors in and around the sella turcica and optic chiasm. Hypophyseal adenomas which al-



FIG. 6. Normal pneumoencephalogram in which cisterna chiasmatis is small and shallow.

most always arise within the sella turcica and subsequently spread into the suprasellar region will nearly always be easily identifiable by the characteristic ballooning of the sella. Hypophyseal duct neoplasms which nearly always originate in the suprasellar region may be identified in a very substantial percentage of cases by the calcification within the tumor and also may cause pressure effects downward upon the sella and clinoid processes. Parasellar tumors commonly show unilateral erosion of the sella and dorsum; a double sellar floor and unilateral clinoid erosion may be

present; the sphenoidal ridge and superior orbital fissure may show evidence of erosion. Meningiomas in the suprasellar region may produce hyperostosis of the tuberculum sellae in some cases. All of these tumors, however, if small, may produce no discernible alteration in the ordinary roentgenogram of the skull. This may even be the case with surprisingly large suprasellar tumors, especially meningiomas.

Pneumoencephalography was formerly considered least informative in tumors in the neighborhood of the sella turcica and optic chiasm. Too often with a negative roentgenogram of the skull and a presumably negative pneumoencephalogram, the



Fig. 7. Normal pneumoencephalogram in which cisterna chiasmatis is large and deep.

neurologist has had to decide for or against operation on the basis of clinical observation alone. Errors in judgment are not rare in this type of case. Therefore, it is felt that pneumoencephalography should be truly recognized as a highly accurate, informative, diagnostic procedure in the clinical investigation of suprasellar tumors. It is noteworthy that in Cases I and III (Fig. 1 and 3) obliteration of the cisterna chiasmatis constituted the only abnormal finding roentgenologically while in the other cases (Fig. 2, 4, 5) it was accompanied by encroachment upon the cisterna interpeduncularis and the floor of the third ventricle.



Fig. 8. Case VI. M. G. (J. H. No. BH8645), female, aged forty-eight. History of increasingly impaired vision for one year; periodic left temporal headaches for a year; sense of pressure in region of vertex for three weeks. Neuro-ophthalmologic examination revealed marked pallor of both optic discs; superior bitemporal, central scotomatous field defects combined with peripheral constriction of both visual fields. Laboratory data, including spinal fluid examination, within normal limits. Roentgenogram of skull negative. Pneumoencephalogram showed poor visualization of the cisterna chiasmatis and an absence of air in the subarachnoid pathways over both cerebral hemispheres with a normal ventricular system. Diagnosis: optochiasmatic arachnoiditis, verified.

It is suggested that in all patients who present the combination of visual impairment and prechiasmal or chiasmal visual field defects with or without headaches it is essential that the diagnostic investigation proceed in regular steps. If in such a patient routine roentgenograms of the skull and the spinal fluid examination fail to disclose significant information it is essential that pneumoencephalography be performed before the diagnosis of a suprasellar tumor is dismissed.

SUMMARY AND CONCLUSIONS

Tumors in the suprasellar region are frequently difficult to diagnose clinically. However, routine pneumoencephalography will

show obliteration of the cisterna chiasmatis in such tumors and permits their early detection. Five illustrative cases are described including four verified suprasellar meningiomas and one unverified hypophyseal duct neoplasm. A control study of one hundred and fifty consecutive pneumoencephalograms in which no suprasellar lesion was suspected shows 94 per cent visualization of the cisterna chiasmatis. Therefore, it is concluded that obliteration of the cisterna chiasmatis warrants the presumptive diagnosis of a suprasellar tumor, if a lesion in this area is clinically suspected. Conversely, clear visualization of the cisterna chiasmatis is sufficient to practically exclude the diagnostic possibility of a suprasellar tumor.

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RETROCARDIAC BRONCHIECTASIS*

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THE importance of bronchiectasis among the pulmonary diseases has been increasingly recognized with the improvement of diagnostic procedures. Although the diagnosis of the extensive and advanced condition is usually suggested by history, symptoms and physical findings, the exact extent and location of the involvement can be ascertained only by the bronchogram, obtained by the endobronchial injection of iodized contrast oil. The now generally accepted fact that chronic bronchial dilatation is an irreversible process and curable only by surgical removal of the involved portions of the lung makes bronchographic examination mandatory as a guide in determining the operability of each case and the extent of the required surgical procedure.

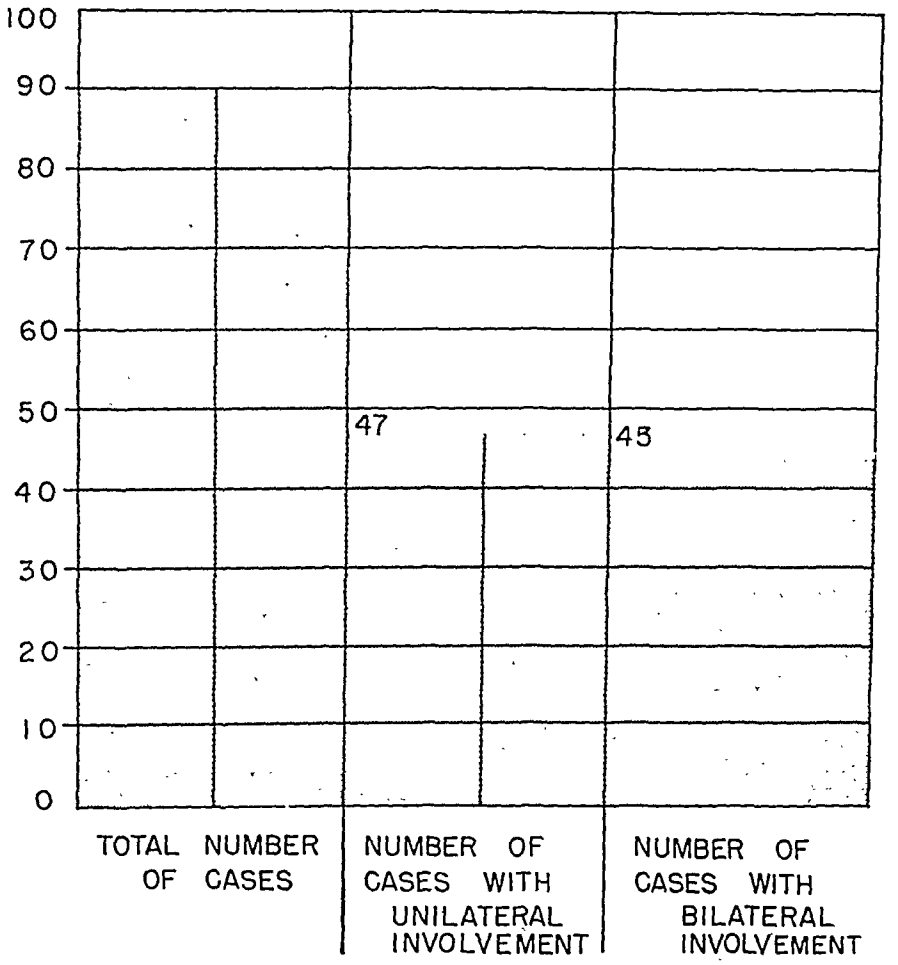


CHART I

From bronchographic records thus accumulated, it is possible to point out peculiarities in the localization and distribu-

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tion of the disease to which only few authors have made reference in the otherwise voluminous literature on bronchiectasis.[1,2,3,4,5] We are referring to the observation that

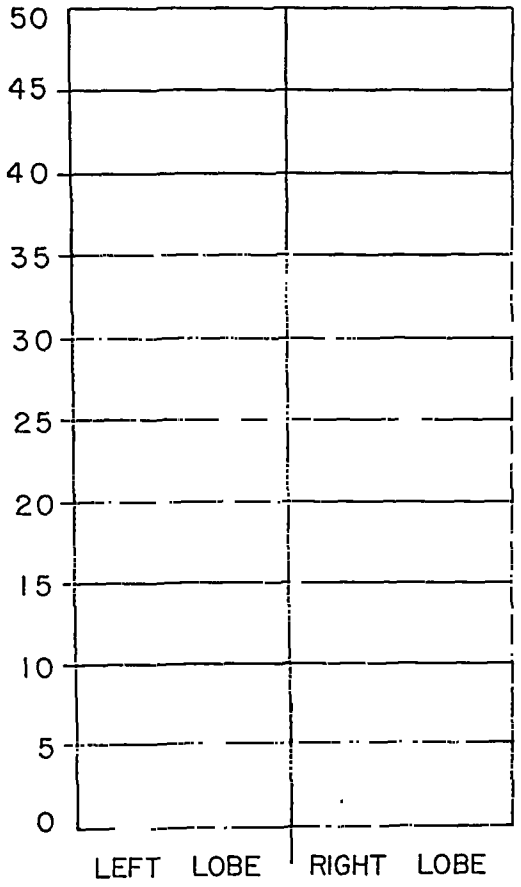


CHART II. Relative incidence of right and left lower lobe involvement.

there is a striking predilection of bronchiectasis for the lower lobe of the left lung. Unilateral involvement which was found in slightly over half of our series of 90 patients (Chart I) had affected the left lower lobe in the great majority of patients, namely in 39 out of 47, or 83 per cent (Chart II). No effort is made in this study to analyze the detailed lobar distribution of bronchiectasis. For the sake of brevity a small number of upper lobe involvements has been omitted as irrelevant for this discussion. Involvement of the right middle lobe usually associated with lower lobe disease has been included with the latter.

Classifying the degree of bronchiectatic involvement by an arbitrary scale of four grades, it was found that unilateral disease, too, occurred much more extensively in the left than in the right lung. Almost half of the left unilateral dilatations occurred in Grades III and IV, signifying extensive disease which was practically absent in patients with right unilateral findings (Charts IV and V). In bilateral disease also the left lower lobe was found more extensively involved than the lower portions of the right lung. Of 43 patients with bilateral involvement, 16 had about equally advanced disease, but 20, or 74 per cent, of the remaining 27 of that group had the left side more extensively affected than the right, often strikingly so (Chart III, Fig. I). Application of the grade classification showed that the left predominant involvement in bilateral disease was generally in a more advanced state than were the right predomi-

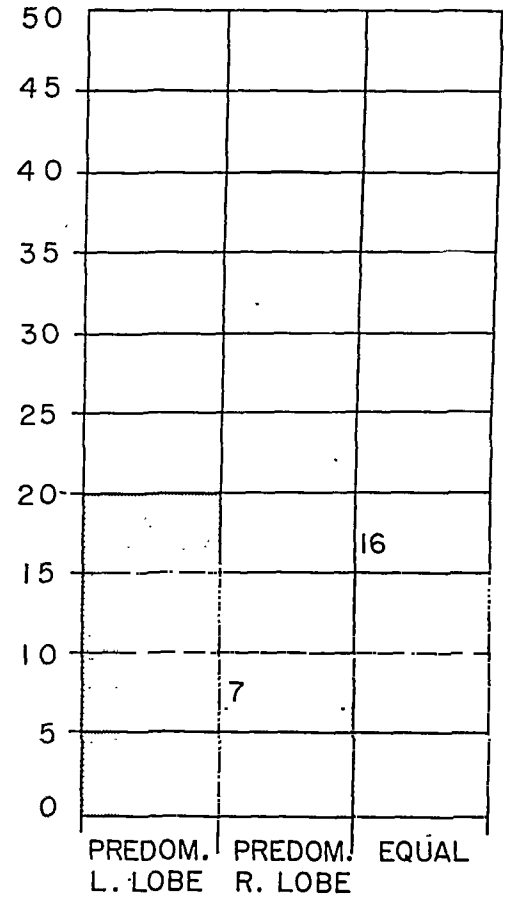


CHART III. Relationship of predominance in bilateral cases.

nant bilateral dilatations (Charts VI and VII). Whenever the extent of bilateral dilatations seemed to be equal in both lungs it was only rarely of the extensive variety (Chart VIII).

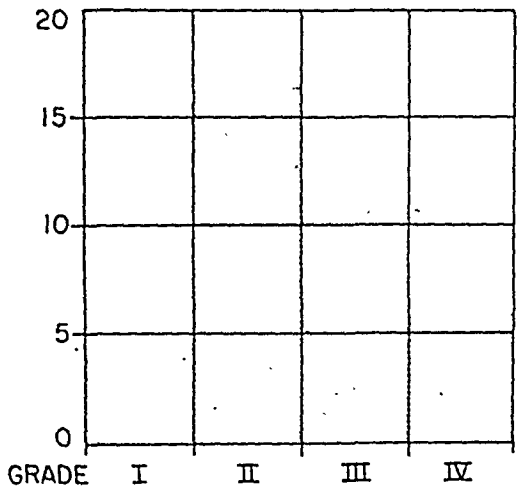


CHART IV. Extent of unilateral left lower lobe involvement.



FIG. 1. Bronchogram of bilateral bronchiectasis showing the greater extent of the involvement in the left lung.

The most important diagnostic aspect of these observations lies in the fact that in routine roentgenograms of the chest, the greater part of the lung field representing the left lower lobe is obscured by the cardiac shadow. Therefore, the visible findings of bronchopulmonary involvement can be minimal and consequently pronounced bronchial symptoms may seem to be out of proportion with the roentgen evidence. Only the bronchogram can reveal the true extent of the disease (Fig. 2). Routine

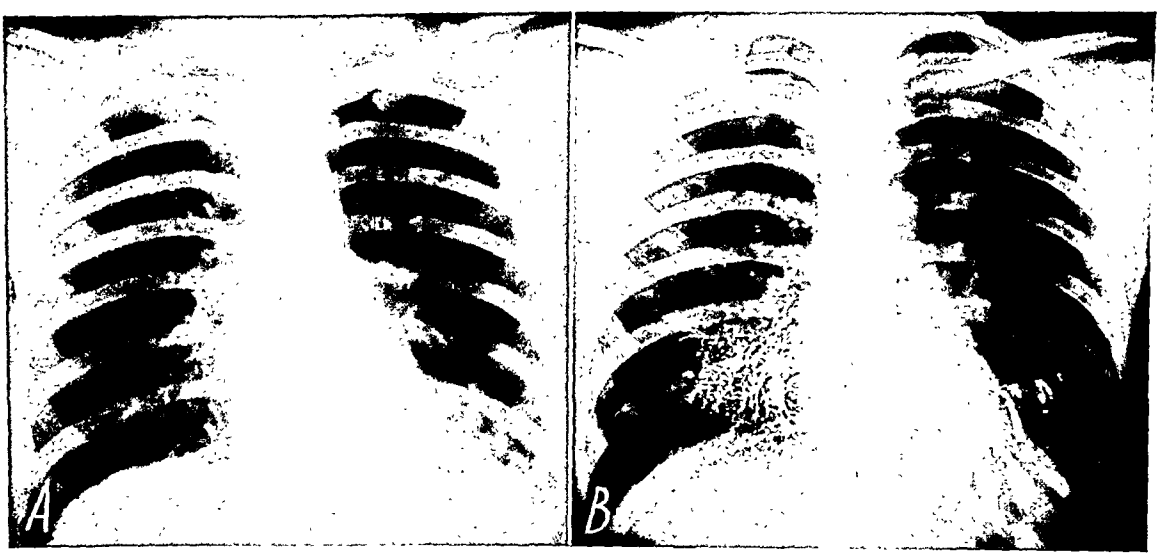


FIG. 2. Routine chest roentgenogram (*A*) showing minimal involvement in and near the left cardiophrenic angle. The bronchogram (*B*) shows the true extent of the disease in the retrocardiac area.

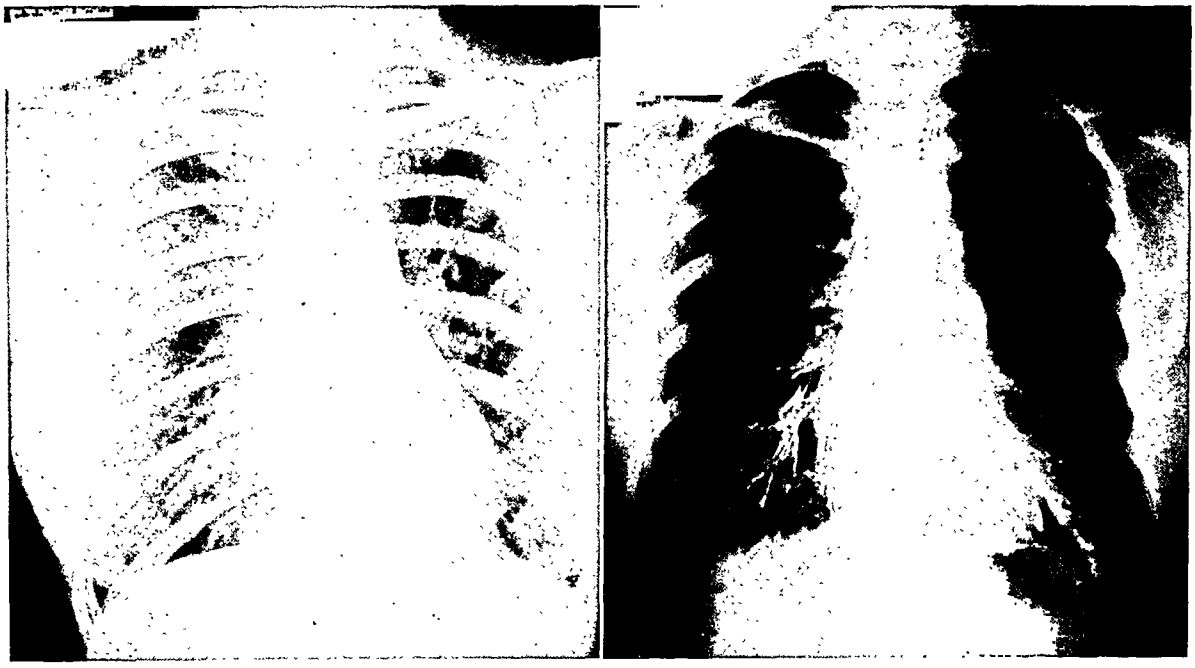


FIG. 3



FIG. 4

FIG. 3 and 4. Essentially normal lung fields in the routine roentgenograms. The bronchograms show extensive bronchiectasis confined solely to the retrocardiac area of the left lower lobe.

roentgen findings in the lung field lateral to the heart shadow can be so minimal as to be easily overlooked, frequently they are non-existent.

Figures 3 and 4 illustrate extensive bronchiectasis confined solely to the retrocardiac area of the lung, demonstrable only by bronchography. Physical findings are more indicative of retrocardiac bronchiectasis than the routine chest roentgenogram although they may be scant in comparison with the severity of the involvement. Frequently they are interpreted as signifying a simple bronchitis, either acute or chronic. It is of great importance to keep in mind in this age of mass surveys that by

roentgen examination only a small percentage of patients suffering from retrocardiac bronchiectasis will be screened out. This was borne out by the experience with numerous cases among personnel in the armed forces[3] where eventually under the unaccustomed stress of the service the increase of symptoms, often recurrent pneumonias, called attention to a pre-existing bronchial dilatation.

The predominance of bronchiectasis of the left lower lobe and especially of the retrocardiac pulmonary area can hardly be explained by the configuration of the bronchial tree. We believe that it is the residual of more extensive bronchial disease in early childhood secondary to the variety of respiratory infections to which bronchiectasis can be attributed. Beginning bronchial dilatations may readjust themselves during the years of growth after the primary cause has disappeared, but the retrocardiac part of the involvement fails to do so because of the traction effect of pericardial adhesions which have resulted from the primary pulmonary infection. This traction can be assumed to be much aggravated by the action of the heart.

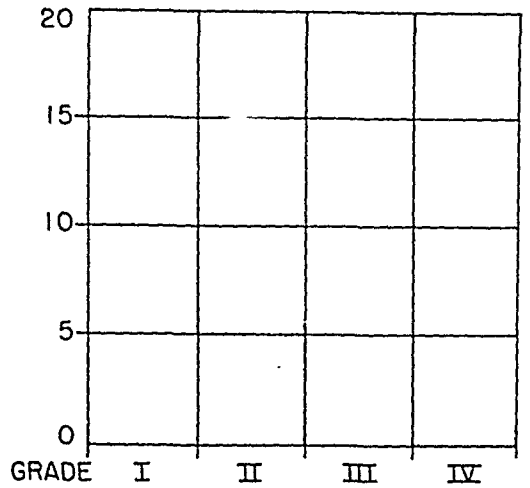


Chart v. Extent of unilateral right lower lobe involvement

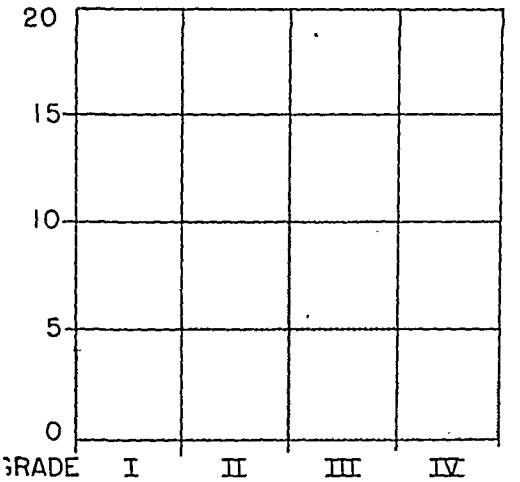


Chart vi. Extent of bilateral disease; predominance of left lower lobe involvement.

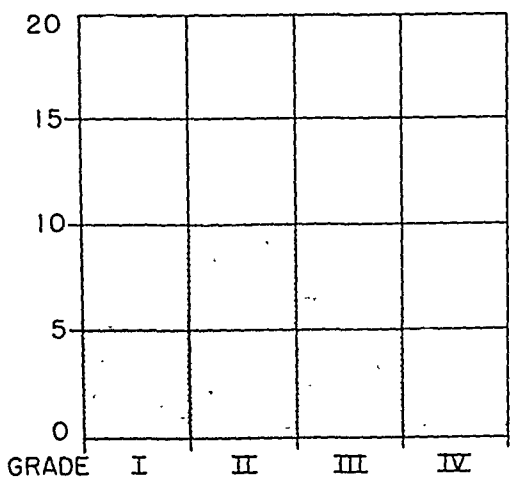


Chart vii. Extent of bilateral disease; predominance of right lower lobe involvement.

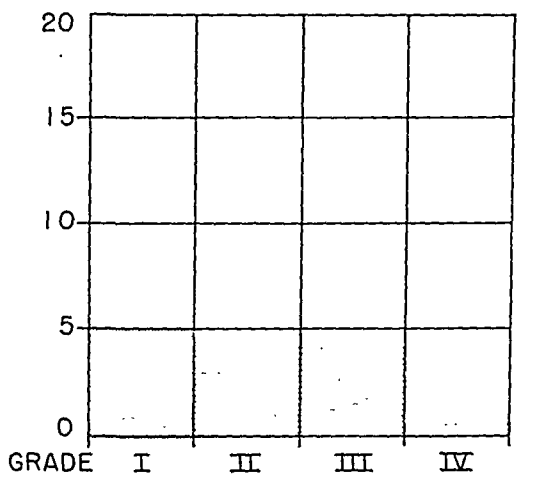


Chart viii. Extent of bilateral disease; equal involvement of both lower lobes.

SUMMARY

1. Bronchiectasis involves the lower lobe of the left lung more frequently and

more extensively than any other pulmonary area.

2. The occurrence of unilateral bronchiectasis is nearly five times as frequent in the left as in the right lung.

3. Isolated bronchiectasis of the retrocardiac area of the left lower lobe is frequent. On routine chest roentgenograms it may escape recognition entirely and can be diagnosed only by bronchographic examination.

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SOME CLINICAL AND PATHOLOGICAL OBSERVATIONS IN A STUDY OF DEGENERATIVE ARTHRITIS OF THE HIP JOINT*

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CASES of degenerative arthritis which are classed as primary are actually instances in which the cause of the degeneration of the articular cartilage is not known. Some of these cases are apparently the result of senescence or wear and tear processes. In the secondary type, the degeneration of the articular cartilage leading to the development of an osteoarthritis has a known basis. Among the more common causes are untreated or inadequately treated Perthes' disease and slipped capital femoral epiphysis, congenital subluxation and dislocation of the femoral head, fractures into and about the hip joint, and aseptic necrosis of the head and neck of the femur from a variety of causes other than Perthes' disease (Fig. 1, *a* to *f*). Any condition which alters the anatomy of the hip joint will accelerate the appearance of degenerative changes incidental to wear and tear of function.

In a study of 81 cases of degenerative arthritis of the hip joint, of both the primary and secondary types, there were 16 in which the arthritis followed upon an aseptic necrosis of the femoral head. The degenerative arthritis was definitely engrafted on a pre-existing lesion of the hip joint in 48 of the 81 cases (59 per cent). Although some of the remaining 33 cases might very well be instances of the primary or spontaneous type, more adequate histories and previous roentgenograms might have excluded some as instances of the secondary type.

Tissue for histopathologic study was available in all of the 81 cases. The changes in the articular cartilage varies from fibrillation to complete erosion at the weight-bearing portions. Exostosis formation is a constant feature of the pathologic anatomy and contributes to the deformation of the bone ends of the joint. The subchondral bone trabeculae become compact and thickened, especially where the articular cartilage is eroded. The marrow of the femoral head becomes replaced in some areas by loose fibrous tissue and by the development of cyst-like cavities. Identical changes are present in the contiguous surface of the acetabulum (Fig. 2*a*).

The pathologic changes are visualized in the roentgenograms as follows: Thinning and loss of articular cartilage is demonstrated by loss of joint space. The thickened and condensed subchondral bone is manifested as sclerosis and there is a corresponding densification of the acetabulum. The cystic areas appear as subchondral areas of radiolucency (Fig. 2*b*). In those instances in which the head is enlarged it may protrude from the lateral confines of the acetabulum and in these cases an osteophytic ledge may appear at the lateral acetabular border. However, true subluxation of the femoral head may appear, the head being displaced laterally and the space between its medial surface and the acetabulum being filled in by the deposit of bone in the acetabular floor and by the medial beak of the enlarged femoral head (Fig. 2*c* and 3).

The combination of loss of articular cartilage over the weight-bearing portion of the head, deposition of bone at the head-neck junction and widening of the neck by actual periosteal bone formation in the neck region, produces a mushroom-like or cauliflower-like femoral head which is not unlike that observed in untreated or inadequately treated Perthes' disease or

* Work done under a Frederick Brown Research Fellowship in Orthopedic Surgery, Hospital for Joint Diseases, New York, N. Y.

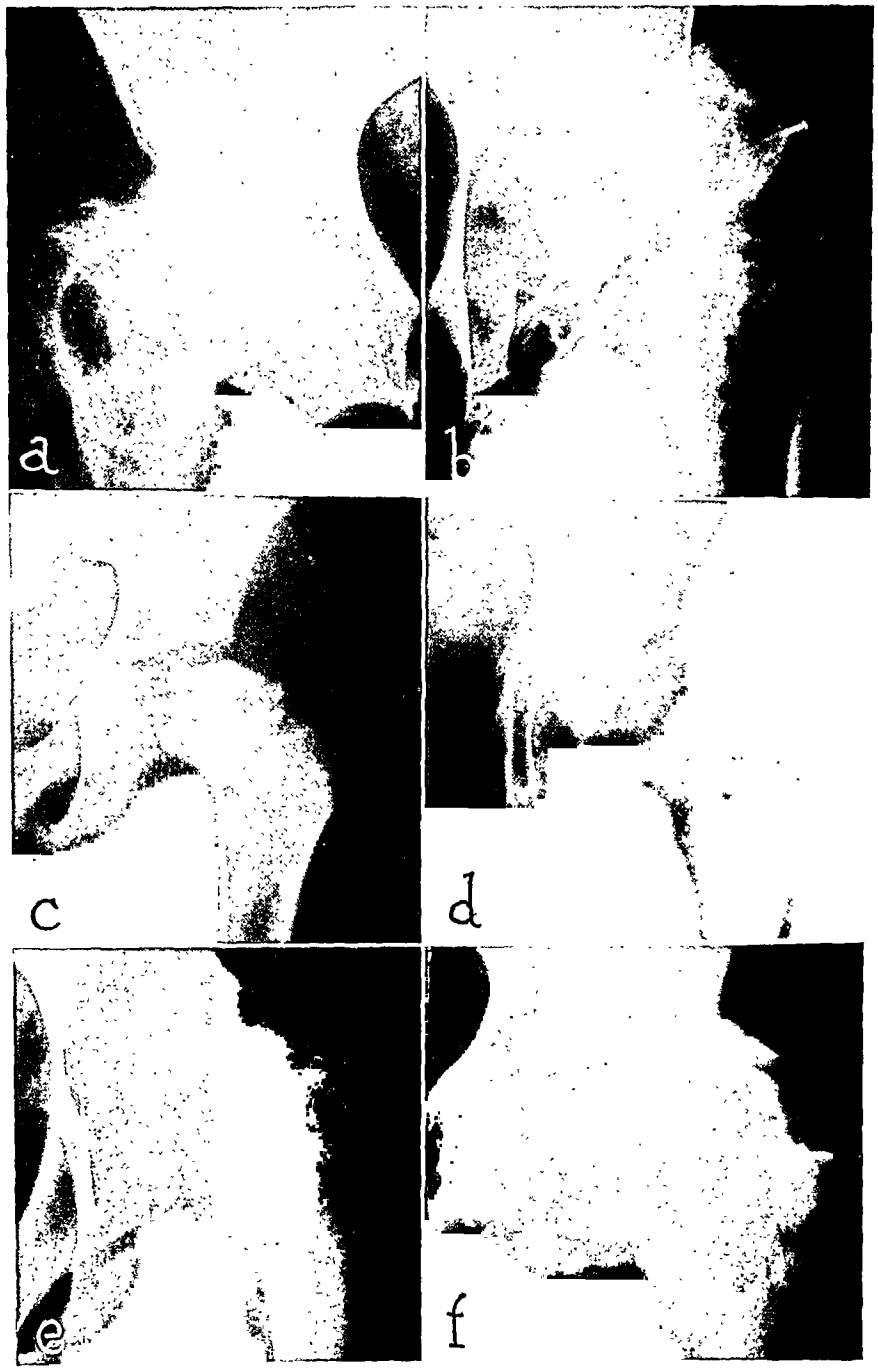


Fig. 1. Anteroposterior roentgenograms of (*a*) right and (*b*) left hip joints in a male, aged forty-five, with pain in both hip regions, more marked on the left side. The patient had been treated for a "limp" since childhood and he was told at the age of twenty that he had a congenital dislocation of the left hip. The right femoral head is subluxated, the acetabulum is defective and shallow, and there is an advanced secondary degenerative arthritis as manifested by loss of joint space, hypertrophy of the femoral head and subchondral osteosclerosis. The left femoral head is completely dislocated well above the original acetabulum. A large mass of bone on the medial aspect of the femoral head, the exact nature of which is more clearly defined in Fig. 2*d*, occupies the secondary acetabulum. Here the contacting bony surfaces are densely sclerotic and only a narrow joint space is visualized.

c. Anteroposterior view of the left hip joint in an eight year old boy showing early changes of Legg-Perthes' disease.

d. The same hip as in *c*, at the age of fifteen. There is a fairly pronounced flattening and mushrooming of the femoral head which now extends well out of the lateral confines of the acetabulum. The deformity

displacement of the capital femoral epiphysis (Fig. 2, *a* and *b*). The latter interpretation, however, should be made only following an evaluation of previous roentgenograms which demonstrate the evolution of the degenerative arthritis on the basis of these lesions (Fig. 1, *c*, *d* and *e*). Similarly, the shallow acetabulum, with or without subluxation of the femoral head, which is observed in some cases of degenerative arthritis, can be differentiated from a primary (congenital) dysplasia of the acetabulum only from an analysis of previous roentgenograms (Fig. 2*c*).

Avascular necrosis of the subarticular bone is not an intrinsic part of the pathologic picture in degenerative arthritis of the hip joint or of any other joint of the body. However, one of the most advanced manifestations of secondary osteoarthritis is found associated with aseptic necrosis of the femoral head (Fig. 2*f*). Aseptic necrosis of the femoral head and neck may follow upon traumatic dislocation of the head of the femur or fracture of the neck of the femur, with or without subsequent union. Indeed, the occurrence of aseptic necrosis and degenerative arthritis has been reported in a surprisingly high percentage of united fractures of the neck of the femur observed from one to two or more years after injury. Although necrosis has been observed to follow external fixation or internal fixation with equal frequency, the latter procedure, assuring a higher incidence of union and allowing earlier ambulation, may be followed by the early appearance of secondary deformity of the femoral head. In this respect, it is significant that an aseptically necrotic head undergoes no deformity in the presence of nonunion of a femoral neck fracture, when there has been little or no direct weight bearing on the affected side (Fig. 2*g*). Aseptic necrosis is also observed after sudden, marked displacements of the capital femoral epiphysis, in the bone ends and shafts in caisson workers (although identical changes have been observed in the femoral heads in persons who have never been caisson workers), and there are instances of "idiopathic aseptic necrosis" which develop on an obscure basis. That necrosis of the femoral head may occur, following sudden and severe displacement of the capital epiphysis, must be borne in mind when methods of treating displacement of the capital epiphysis are evaluated, especially in regard to the appearance of postoperative complications such as aseptic necrosis and degenerative arthritis.

In aseptic necrosis of the femoral head the nutrition of the articular cartilage becomes affected and a secondary osteoarthritis supervenes if the underlying bone is not replaced by normal bone, and, in cases of long standing, this osteoarthritis becomes greatly exaggerated with collapse and deformity of the femoral head. Pathologic fractures may occur between the dead and

has resulted from compression of the capital epiphysis, from lateral growth of this epiphysis over the neck superiorly, and from widening of the femoral neck due to actual periosteal bone deposition. This is quite unlike the deformity in degenerative arthritis of primary or spontaneous origin where the malformed head becomes greatly modified secondarily, by hypertrophic deposits especially at the head-neck junction. Note how the shape and depth of the acetabulum have become altered secondarily to conform to the outline of the deformed femoral head. Such a hip joint as is illustrated here must inevitably become the site of secondary degenerative changes as a result of malformation and incongruity of its bony components.

e. Anteroposterior view of the painful left hip in a sixteen year old boy. A moderate displacement of the capital femoral epiphysis had been treated at the age of thirteen by multiple drillings across the epiphyseal plate. The right femoral head had also been involved but had healed with minimal deformity and no residual pain. Histopathologic study of tissue removed at the time of arthrodesis of the left hip joint showed an advanced degenerative arthritis without any evidence of aseptic necrosis.

f. Anteroposterior view of the left hip in a fifty-six year old male with pain in both hip regions of ten years' duration. The osteoarthritis was equally advanced in both hip joints and this case is considered as a possible instance of degenerative arthritis on the basis of senescence or wear and tear processes. Histopathologic study revealed the changes of an advanced osteoarthritis and no evidence of aseptic necrosis.



Fig. 2. *a.* Coronal section through the center of the right hip joint of a sixty year old female who died of melanomatosis and who gave a history of pain in the right hip of one year duration. The femoral head appears flattened, the joint space is narrowed and the articular cartilage is thinned, especially superiorly where the subchondral bone is densified. There are areas of fibrosis and cyst formation on the acetabular side and there is an enormous exostosis at the medial portion of the femoral head which contributes to its mushroomed appearance.

b. Roentgenogram of another coronal section of the specimen in (*a*). This shows more clearly the cystic areas in the femoral head and the large exostosis which extends medially beyond the thickened border of the femoral neck.

c. Anteroposterior roentgenogram of the right hip joint in a fifty-one year old female who had had a painful right hip for two years. The femoral head is enlarged and appears somewhat flattened. The joint space is markedly narrowed especially at its superior portion where the contiguous bony structures are densely sclerotic. There is a large radiolucent area in the lateral portion of the enlarged head which protrudes from the confines of the acetabulum. The enlargement of the head is due to bony deposition at the

living portions and result in collapse of the subchondral bone, delayed union and even in nonunion. The process of bone replacement may be "arrested prematurely" before its completion. For example, residual islands of dead bone have been observed many years after the clinical conclusion in Perthes' disease. For this reason even early recognition and the most judicious measures of protecting the affected areas may fail to prevent collapse and deformity.

In the writer's material, the head fragment in 2 cases of ununited fracture of the femoral neck, even though viable and without histopathologic evidence of aseptic necrosis, manifested secondary degenerative changes in the articular cartilage (Fig. 2*e*). The wisdom of exploring the hip joint so as to visualize the articular surface of the head fragment prior to reconstructive surgery becomes apparent. When this surface is extensively modified, those procedures which aim to preserve the femoral head are contraindicated and a procedure which entails removal of the head fragment or an arthrodesis appears to be in order.

The roentgenogram is not always a reliable method of interpretation in the diagnosis of aseptic necrosis. Necrotic bone will usually appear opaque in the roentgenogram as compared to the viable bone about it. Alterations in density result from atrophy of disuse, creeping replacement of dead bone by viable bone, pathologic fracture and collapse of dead bone bordering on joints, compression of dead trabeculae and infiltration of "bone sand" into the dead marrow spaces. However, should the process of resorption of the original bone keep pace with new bone formation, such sclerosis may not be evident. Indeed, there have been instances in my material in which the roentgenographic interpretation of the presence or of the absence of an aseptic necrosis has not been sustained by a thorough histopathologic survey of the tissue removed at the time of reconstructive surgery (Fig. 3*d*).

CONCLUSIONS

1. Degenerative arthritis may be classified as being primary or secondary. Those cases which are classed as primary are actually instances in which the cause of the degeneration of the articular cartilage leading to the development of an osteoarthritis is not known. Some of these cases, however, are apparently the result of senescence or wear and tear processes. In the secondary

head-neck junction. The acetabulum appears shallow in consequence of erosion at its superior border. The possibility of a pre-existing acetabular dysplasia could have been ascertained accurately only from roentgenograms made earlier in life.

d. Coronal section through the center of the resected femoral head and neck in a forty year old female with an unreduced congenital dislocation and with a history of pain for twelve years. The upper two-thirds of the specimen represents the original femoral head, now flattened and deformed. There is almost complete loss of the articular cartilage and there are marked alterations, including cystification, in the subchondral region. The lower third of the specimen represents an enormous exostosis formation and this had filled the original acetabulum.

e. Coronal section through the center of the femoral head fragment in a forty-three year old female with an ununited fracture of the left femoral neck of two years' duration. There is marked thinning and shredding of the articular cartilage, much fatty marrow in the head fragment and fibrous tissue at the site of nonunion. Microscopic sections revealed viable bone, no evidence of aseptic necrosis, and degenerative changes in the articular cartilage.

f. Coronal section through the center of the femoral head fragment in an elderly female with an ununited fracture of the neck of the left femur of about five years' duration. There is an advanced degeneration of the articular cartilage and a wedge-shaped area of aseptically necrotic bone.

g. Anteroposterior view of the left hip in a fifty-eight year old female who had sustained a fracture of the neck of the femur five years previously. The fracture is ununited and the neck is partially resorbed. Note that the contour of the head fragment is well preserved. Histopathologic sections of the excised capital fragment demonstrated an extensive aseptic necrosis and marked degeneration of the articular cartilage.

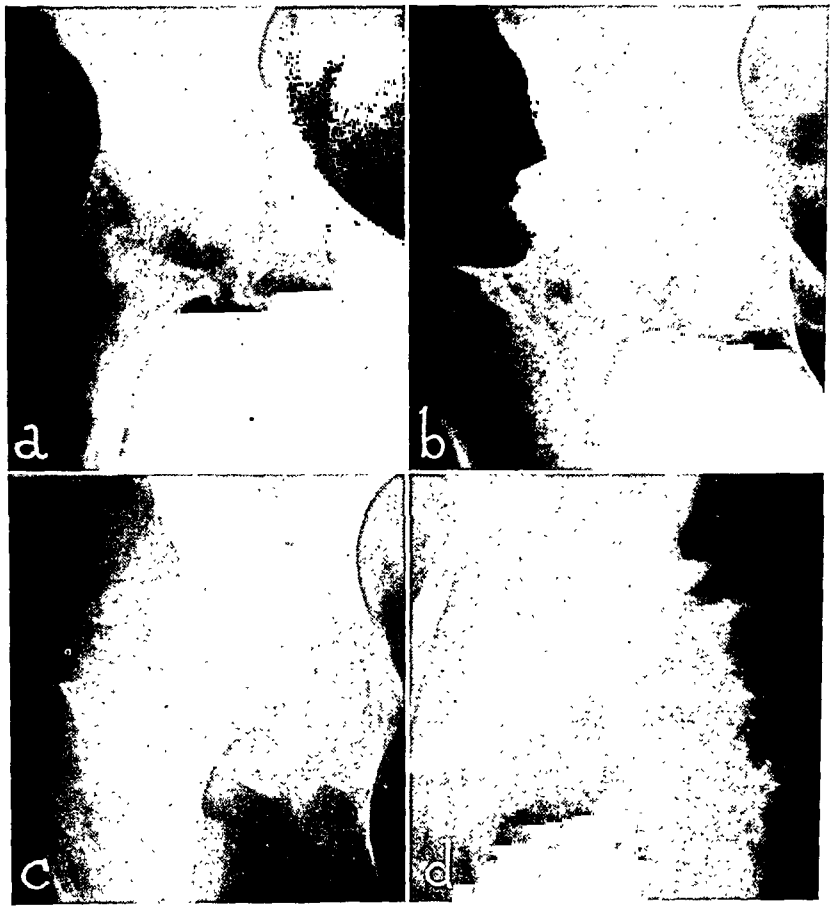


Fig. 3. Stages in the development of the roentgenographic features of degenerative arthritis as manifested by narrowing of the joint space, subchondral sclerosis and cystification, and marginal hypertrophy of the femoral head and neck and of the acetabular rim. Specimens removed at the time of arthroplasty in (*a*), (*b*) and (*d*), and arthrodesis in (*c*) showed the histopathologic changes characteristic of degenerative arthritis in all of these cases.

a. Anteroposterior view of the right hip joint in a fifty-four year old female with pain of three years' duration. There is beginning marginal spurring at the head-neck junction.

b. Anteroposterior view of the right hip joint in a forty-four year old female with pain of six years' duration. The femoral head is hypertrophied and there is a large spur at the superior margin of the acetabulum.

c. Anteroposterior view of the right hip in a forty year old male with pain of one year duration. There is marked proliferation of bone medially and laterally, creating an enormous femoral head which appears to extend from the confines of the acetabulum.

d. Anteroposterior view of the left hip joint in a forty-nine year old male with pain of fourteen years' duration. Deposition of bone at the head-neck junction in the form of a collar is more marked than in (*c*). The history of underground work as a coal miner for twenty years and later as a tunnel worker, and of the "bends" five years previously, and the patchy sclerosis of the head and neck suggested the possibility of an underlying or complicating aseptic necrosis, but this was not sustained by histopathologic study of all material removed at the time of surgical reconstruction.

type, the degenerative changes have a known basis.

2. In the development of the gross anatomical features in degenerative arthritis of the hip joint, the combination of loss of articular cartilage over the weight bearing portion of the femoral head, deposition of bone at the head-neck junction and widening of the femoral neck, produces a flattened, mushroom-type of deformity. The acetabulum may be shallow and the femoral head may appear subluxated. This deformity should be differentiated from the residual deformity in untreated or inadequately treated Perthes' disease or displacement of the capital femoral epiph-

ysis and congenital dysplasia of the acetabulum, with or without luxation of the head of the femur.

3. Although aseptic necrosis of the subarticular bone is not an intrinsic part of the pathologic picture in degenerative arthritis, one of the most advanced manifestations of secondary osteoarthritis is found associated with aseptic necrosis of the femoral head, arising from a variety of causes. The degenerative articular lesion in these cases becomes greatly exaggerated with collapse and deformity of the femoral head and this may even follow prolonged protection of the affected head when it fails to become fully revitalized. The occurrence of aseptic necrosis in the femoral head following sudden and severe displacement of the capital epiphysis must be borne in mind in the evaluation of methods for the treatment of this condition and its complications.

4. The diagnosis of aseptic necrosis from the roentgenograms alone is not always accurate. This is particularly significant in light of the attention now being focused on the aseptic necrosis and degenerative arthritis appearing one or more years following union of femoral neck fractures which have been treated by internal fixation. Degeneration of the articular cartilage of the femoral head may supervene even in the presence of a viable head fragment in fractures of the femoral neck, and this must be considered in selecting the most suitable reconstructive procedure for the treatment of delayed union and nonunion.

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HYPERTROPHIC OSTEOARTHROPATHY*

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SINCE the original report of Marie[17] and von Bamberger,[29] numerous articles regarding subperiosteal new bone formation have appeared in the literature. It has become obvious that this condition does not always result from primary involvement of the lungs. Although it is most common in pulmonary changes, it has been found in diseases of the heart, liver and blood, and recently a case was reported by Miller[21] showing typical changes of pulmonary osteoarthropathy secondary to a carcinoma of the thymus. Kline[14] recently had the opportunity of following a case of a young male with pulmonary and bone tuberculosis who developed a very extensive hypertrophic pulmonary osteoarthropathy.These changes have also been reported in the rat[27] dog,[3,11] horse,[2,15] and lion.[2] Most of the cases reported in dogs were secondary to pulmonary tuberculosis, but Wissing and Weisz[31] found its occurrence in a dog secondary to the presence of a highly malignant invasive bronchogenic carcinoma.

The study of this condition was stimulated by the admission of several patients to the hospital with the diagnosis of rheumatoid arthritis. They had been seen by physicians not connected with the hospital and had been treated for joint symptoms a considerable time without relief. There were no symptoms referable to the chest. Subsequent roentgenograms showed hypertrophic osteoarthropathy, thus strongly indicating the presence of an abnormal lung condition. This supposition was given in the roentgen report and in all cases proved to be correct. A review of the hospital records revealed several additional cases with identical stories. Craig,[6] in 1927, also reported 4 cases in which the pain and changes in the extremities led to the discovery of a pulmonary neoplasm. Holt and Hodges,[12] in their recent monograph, also called attention to the possibility of diagnosing longstanding chronic pulmonary or mediastinal disease by clinical and roentgen examination of the hand.

Previous literature on this subject is somewhat confusing as many of the cases listed under this entity have no histopathological proof. Many of the cases have only had simple clubbing of the fingers. Numerous investigators believe that clubbing and hypertrophic osteoarthropathy arise from the same causes, and that hypertrophic osteoarthropathy merely represents an advanced stage of the clubbing. Such reports include those of Locke[16] Mendlowitz,[19] Weens and Brown,[30] Fishberg,[7] Kessel[13] and Montgomery.[22]

Early reports indicated that tuberculosis and bronchiectasis were by far the predominating causes of hypertrophic osteoarthropathy. Recent reports show that carcinoma of the lungs is more prevalent. It is highly probable that the earlier cases which were thought to be tuberculosis or other conditions, were actually lung malignancies. As recently as 1938 Odessky and Shirshnev[23] reported a case of extensive subperiosteal new bone formation secondary to what he called a "catarrhal pneumonia." This pneumonia did not recede over a long period of time, and, in the roentgenograms which were produced with the article, there is a shadow which certainly suggests a bronchogenic carcinoma. If all patients with a diagnosis of carcinoma of the lung had roentgenograms taken of the extremities, the incidence of hypertrophic osteoarthropathy would undoubtedly be higher since this condition can be present without giving symptoms or signs.

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PATHOLOGICAL FINDINGS

Grossly, the process is essentially one of chronic proliferative subperiosteal osteitis surrounding the shaft of the bone, viz., tibia, fibula, radius and ulna, less frequently the humerus and femur or proximal portion of the phalanges. In the very advanced cases the clavicle, spines of the scapulae or vertebrae may be involved. The involvement is absent at the ends of the shaft where there is supposedly no periosteum. The new bone formation is from 1 to 7 millimeters thick and has a thin cortex surrounding the new cancellous bone which fills in the space between this new thin cortex just beneath the periosteum and the old cortex, which appears intact. This new bone formation is extremely vascular and there are recorded attempts at biopsy which have resulted in excessive hemorrhage and the necessity of packing before bleeding is controlled. This new bone is soft and pliable and easily cut or torn away from the old cortex. The clubbing of the fingers is said to be due, by most authorities, to soft tissue changes and there is no bone involvement. This consists of connective tissue thickening. Weens and Brown,[30] however, reported that absorption of the terminal phalanges may occur, and that these changes are preceded by hypertrophic changes. They illustrated cases where complete absorption of the unguinal process had occurred, giving the terminal phalanges the appearance of a thumb tack, and in some instances absorption had progressed so far that only the base of the terminal phalanx remained.

The joints are also involved. Some authors claim that nearly one-third of the cases have joint involvement consisting of a synovitis which may progress to actual erosion and ankylosis. Certainly the joints show extensive involvement clinically. Microscopically one can also see lymphocytic infiltration of the synovial membrane. The early microscopic changes consist of thin layers of new bone formation just beneath the periosteum which lie, layer on layer, surrounding the cortex of the original shaft. Perhaps six or more of these layers are distinguishable.

In the more advanced cases of this new bone formation the bone becomes firm but still presents a picture of a thickened bone surrounding the shaft with a thin, hard cortex just beneath the periosteum. No longer can distinct layers be detected, but it still remains quite vascular and, in the extreme cases, microscopically there has been reported erosion of the outer surface of the old cortex.

ROENTGENOGRAPHIC FINDINGS

These are exactly as one would expect from the above description of the gross changes and even the microscopic pathological findings. One question deserves comment—that of involvement of the terminal tuft of the fingers. Of the numerous cases of clinical description of clubbing of the finger, very few are recorded of actual flaring or mushroom appearance of the terminal tuft. After careful review of the literature and observation of routine roentgenograms of the fingers, it is our opinion that there are no bone changes in the terminal phalanges in this condition, and that the findings of lateral projection of the tuft can be seen in normal patients. We were unable to demonstrate any of the findings reported by Weens and Brown.[30]

THEORIES OF ETIOLOGY

Few of the very rare bone conditions have received as much attention as this disease. There are many theories, none of which satisfactorily explains the entire picture. Attempts to produce hypertrophic osteoarthropathy were universally unsuccessful. Von Bamberger placed material from a human lung abscess into the rectum of a rabbit; Compere, Adams and Compere[5] injected paraffin into the lungs of a dog and produced abscesses; Phemister[24] used various organisms intravenously while Harter and Churchill[10] tied off the bronchi in cats and monkeys. None of these experiments were successful in producing hypertrophic osteoarthropathy. Mendlowitz

and Leslie[20] anastomosed the left pulmonary artery to the left auricular appendage in four dogs. One developed hypertrophic osteoarthropathy while three did not. In the animal developing the hypertrophic osteoarthropathy, they were able to demonstrate an increased systemic blood flow. The purpose of their operation was to simulate the circulatory changes occurring in congenital heart disease with cyanosis. They thought that the chronic increased blood flow with increased periosteal nutrition was responsible for the proliferation of subperiosteal new bone.

Other theories varied from toxic absorption of infection within the chest to alteration of acid base equilibrium through decreased aeration as a result of compression of pulmonary vessels, constriction of the bronchi, lung compression or collapse. MacCallum,[18] in his textbook, agrees with the toxic theory in which absorption of poisonous material from the widened and infected bronchi is the cause of the changes in the extremities. Freund[8] reported a case of periosteal new bone proliferation without demonstrable pulmonary disease. The amount of bone production was markedly excessive, and occurred at the age of fourteen years. This author also believed the etiology to be toxic, but he was unable to find the source of the toxin. He thought it to be a proteinogenic substance which was not destroyed in the liver and entered the circulation and caused periosteal bone growth. He thought that this was a familial idiosyncrasy. He suggested this toxin might be related chemically to the product arising in various lung diseases which also became distributed throughout the body and reached the periosteum to lead to osteogenesis. Fried[9] analyzed 4 cases of hypertrophic osteoarthropathy in patients with bronchogenic carcinoma. Each of these cases showed pituitary dysfunction, and on the basis of data obtained, he believed that the bone changes were not caused by toxin or circulatory disturbance, but rather by endocrine imbalance, closely related to acromegalia and to pachydermia with pachyperiostosis. Campbell, Sacasa and Camp[4] postulated that the transference of oxygen from the blood is dependent upon the oxygen tension in the blood being less effective where the circulation is slow, as it is in the hands and feet. This decrease in oxygen tension was brought about by faulty aeration of the blood which passes through the lungs. This toxemia leads to edema where the circulation is slow, namely in the extremities.

In nearly all cases there is no clinical evidence of obstruction to the venous return of the blood, but rather, according to Campbell, there is "a varying amount of lung tissue which has ceased to fulfill its proper function." This seems highly improbable in view of the fact that a circular or peripheral carcinoma of the lung, only 4 or 5 centimeters in diameter, is capable of producing marked bone and soft tissue changes, the symptoms of which can be promptly relieved by a pneumonectomy. It is obvious that there has been a marked reduction in the amount of lung tissue remaining following the operation when compared with the area involved by the tumor itself. It is, however, difficult to think that anything except immediate improvement of circulatory conditions could be responsible for such a rapid improvement in clinical symptoms. Prompt and complete disappearance of the symptoms after a pneumonectomy was seen in 1 of the cases to be reported, and disappearance of the symptoms following radiation therapy in 2 other patients. Van Hazel[28] reported prompt relief of symptoms in 1 of his patients who had been bed-ridden for six months, following the removal of a benign intrathoracic neurofibroma. He also cited 12 cases from the literature where rapid improvement followed excision of a thoracic tumor, lobectomy or pneumonectomy. Several authors have expressed the opinion that at least two factors are necessary to produce the secondary osteoarthropathy, namely, a toxemia from long-standing disease and circulatory disturbances resulting from either cardiac or pulmonary involvement. Harter

believed that the condition was due to lack of oxygen, and called attention to the somewhat similar changes found in some people living at high altitudes where oxygen is rare. This observation seems significant.

Locke[16] did not believe that uncomplicated heart disease was capable of producing periosteal new bone formation. He was unable to find any cases in the 144 that he described, his own and those reported from the literature. He stated that "in view of the high incidence of heart disease and the care with which it is studied throughout the world, it seems significant that no cases of uncomplicated heart disease with clubbed fingers have had periosteal new bone formation roentgenographically demonstrated." He believes that "if the combination is not truly non-existent it must be at least extremely rare." Holt and Hodges[12] state that pulmonary osteoarthropathy occurs more frequently in non-tuberculous cases and that they were unable to find a single instance of its occurrence in uncomplicated pulmonary tuberculosis in the case records of the University Hospital.

CASE REPORTS

Case I. M. O., female, aged fifty-three, was admitted to the hospital with a chief complaint of stiffness of the hands and knees of four months' duration. She had been referred by her local physician, who was a prominent arthritis specialist, because of joint symptoms. She had developed progressive swelling, stiffness and pain in the ankles, knees and hands. Later the wrists became involved. The pain was not too severe but there was considerable limitation of motion. She received one gold injection without relief. There was a 20 pound weight loss and considerable weakness.

Her past history and family history were unimportant.

Physically, she appeared to be chronically ill. The extremities presented swelling of the hands so she was unable to make a fist. The wrists were swollen and stiff. The knees and ankles were also swollen, tender and edematous.

The clinical impression was rheumatoid arthritis.

Blood count revealed a secondary anemia.

Roentgenograms of the extremities were ordered. These showed evidence of periosteal proliferation along the shafts of the long bones. The impression was that of a Marie Bamberger syndrome and a chest roentgenogram was recommended. This showed a previously unsuspected circular shadow in the left upper lobe with a pleural effusion. The impression was that of a bronchogenic carcinoma.

A bronchoscopic examination showed slight displacement of the trachea.

She was given a course of deep roentgen therapy to the tumor mass which resulted in regression of the tumor, and there was a considerable improvement in the symptomatology attributable to the hypertrophic pulmonary osteoarthropathy. She was discharged, but returned to the hospital eight months later with evidence of extensive metastases. Thoracentesis showed malignant cells in the pleural fluid. She died at home after a retrogressive course.

Case II (Fig. 1 and 2). E. D., male, aged fifty-two, was admitted to the hospital with a chief complaint of pains in the joints for a



Fig. 1. Case II. There is marked periosteal proliferation along the shafts.

year and a half. He had first noted swelling of the ankles that later became painful. The knees then became involved and the ankles improved. However, other joints subsequently became involved and were painful and swollen. There was also blurring of vision and a 30 pound weight loss occurred. He also was treated by a local physician for a progressive arthritis. At no time were there any symptoms referable to the lungs.



FIG. 2. Case II. There is a large mass with scalloped margins suggesting tremendously enlarged nodes.

Physically, the patient appeared to be cachetic. There was a right lateral proptosis. Examination of the chest revealed dullness anteriorly on the left with rales at the bases. The left leaf of the diaphragm was fixed. The heart was enlarged. The liver was enlarged. The fingers showed terminal clubbing. There was soft tissue proliferation about all the joints. These were tender.

A chest roentgenogram showed a very large mediastinal mass, thought most likely to be a lymphosarcoma with tremendously enlarged nodes. Roentgenograms of the extremities showed marked periosteal proliferation of all long bones. There was destruction of the terminal phalanx of the left thumb due to metastasis.

A course of deep roentgen therapy was given to the chest on the presumption that this was a lymphosarcoma. There was no response to therapy. The left thumb was disarticulated and the pathologist reported metastasis due to undifferentiated bronchogenic carcinoma. The patient's condition became very poor and he was discharged for terminal care.

CASE III (Fig. 3, 4 and 5). N. A., male, aged forty-four, complained of swelling and pain in the joints of nine months' duration. He first noticed pain, swelling of the ankles, knees, toes, fingers and wrists. His local physician made the diagnosis of rheumatic fever. He was treated on this basis and some improvement of symptoms occurred. Movement improved, but the pain persisted. About ten weeks before admission to the hospital, there was sharp pain in the interscapular region. He was admitted to another hospital where the first chest roentgenogram was made. This was interpreted as a "lung infection." An operative procedure was performed but the results were unknown to us. No relief was obtained. At the time of admission, joint pain was considerable and the back



FIG. 3. Case III. The joints were swollen, tender and stiff. The periosteal proliferation is extremely marked.

pain was related to respiration. There was a weight loss of 40 pounds.

On physical examination, the patient appeared to be poorly nourished and chronically ill. There were palpable nodes in the axillary and inguinal regions. There was a well healed incision over the medial border of the right scapula. Dullness was elicited over the right chest anteriorly. Breath sounds were diminished. All fingers and toes showed evidence of marked clubbing. The wrists, knees and ankle joints were swollen.

Roentgenograms of the chest showed a large,

soft tissue mass, approximately 11 cm. in diameter, associated with atelectasis of the right upper lobe. There was right pleural effusion. Roentgenograms of the extremities

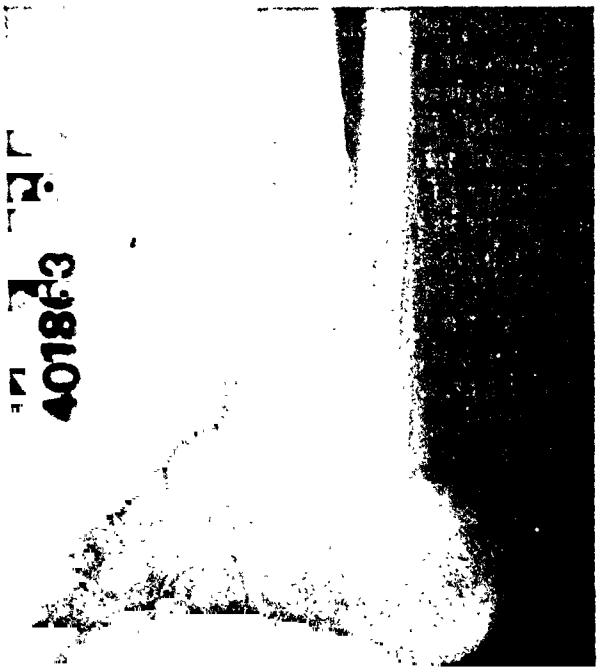


FIG. 4. Case III.

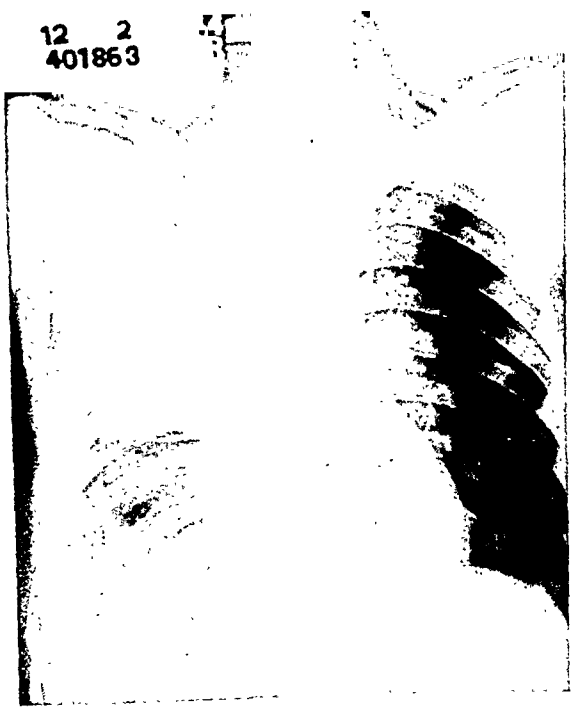


FIG. 5. Case III.

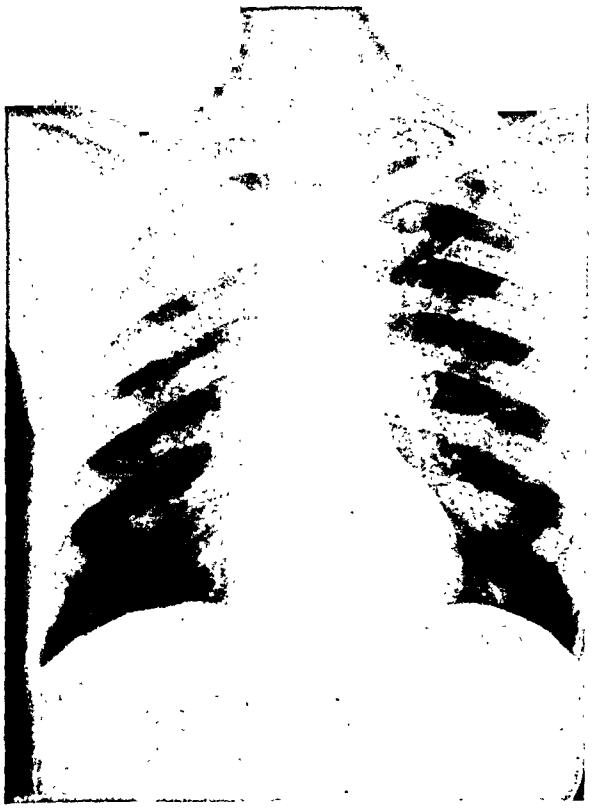


FIG. 6. Case IV. There is a large round mass in the right upper lobe which was proved to be a bronchogenic carcinoma.

showed extensive periosteal, new bone formation.

A biopsy of a right supraclavicular node showed a metastatic mucous adenocarcinoma. Bronchoscopic examination revealed extrinsic pressure on the trachea.

The patient was treated with deep roentgen therapy but without any beneficial effect. He was then discharged to a home for incurables.

CASE IV (Fig. 6, 7 and 8). E. S., male, aged fifty-six. This patient first noted clubbing of his fingers which was followed several months later by pain in the hips. Just before admission the pain became extreme, and involved the knees, which became hot, tender and swollen. There was disability of the hands, fingers, wrists ankles and toes. There was also pain in the right anterior lower chest. This, however, did not occur until late in the disease. This patient was seen by an outside physician and was being treated as a case of rheumatoid arthritis with gold therapy. A routine chest roentgenogram showed a mass in the right upper lung field. At this time there were still no symptoms referable to the chest, but shortly after, there was pain

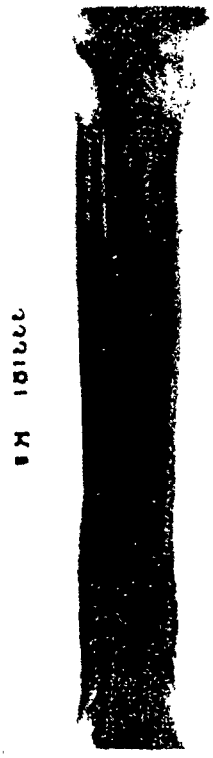


FIG. 7. Case IV. The periosteal new bone formation involves the entire lengths of the shafts.



FIG. 8. Case IV. The joints were very tender. The patient was being treated for rheumatoid arthritis. The metatarsals show periosteal proliferation.

associated with a cough and sputum. Subsequent workup in the hospital demonstrated a carcinoma of the right upper lobe. A right pneumonectomy was performed. Before operation, roentgenograms of the long bones showed hypertrophic, pulmonary osteoarthropathy of the long bones of the hands and feet.

The patient made an uneventful recovery from the operation, but later he was readmitted because of pain in the right shoulder. Roentgenograms of the extremities showed some improvement in the appearance of the pulmonary osteoarthropathy. He was discharged and did quite well for several months. He was again admitted the third time because of very severe pain in the right shoulder and radiation down the right arm. On physical examination, there were massive metastatic cervical lymph nodes as well as nodes in the left axilla. A chordotomy and posterior root section from the 1st to the 6th cervical vertebra were performed. The patient died on the sixth postoperative day.

CASE V (Fig. 9 and 10). O. T., aged fifty-one, was referred from another institution because of a bad taste in the mouth, nausea and vomiting. His father died of tuberculosis and his mother of Bright's disease. He had had pneumonia in 1918 and malaria at the age of eigh-

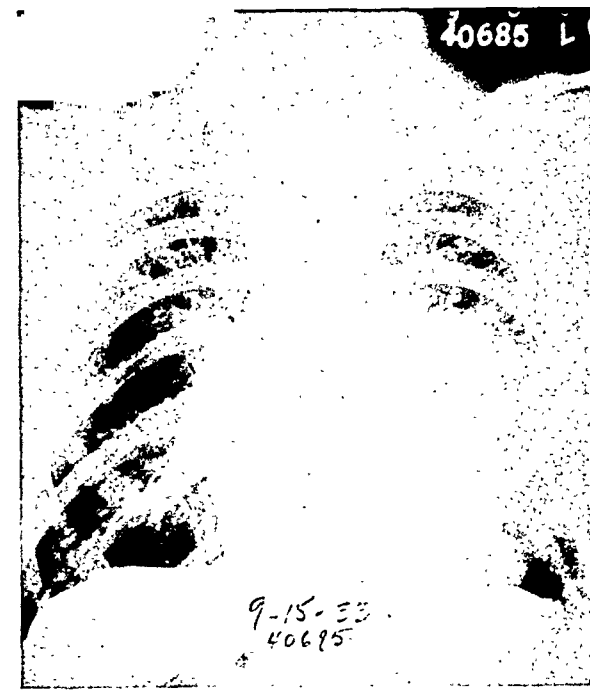


FIG. 9. Case V. There is a large, rounded mass in the left hilar region. A surgical defect of the left ninth rib is present.

teen. There was a history of a luetic and neisserian infection in 1898. Several years before admission, the patient began to suffer with swelling, stiffness and in pain the right knee and ankle, and to a lesser degree in the left. There was some fever. A tonsillectomy was performed, following which the patient complained of a bad taste in his mouth and a foul breath. There was no symptoms referable to the chest, but there was a weight loss of 40 pounds. His serological test was found to be positive and anti-luetic therapy was started. There was slight improvement, but the symptoms soon recurred, for which the patient was re-admitted to the hospital. A routine chest roentgenogram was made at this time and what was thought to be an encapsulated empyema was seen. A thoracotomy was performed but no evidence of pus was obtained. The surgeon thought he was able to palpate a mass. Subsequent roentgenograms showed a definite mass in the left lung. He was then referred to the New York Hospital. At the time of admission, he was both acutely and chronically ill. The ankles were swollen and painful. The toes and fingers were clubbed. Coarse and medium rales were heard over the lower half of the left lung. There was a moderate anemia. The Kline reaction was 4 plus. A chest roentgenogram showed a fairly well circumscribed mass, thought to represent a new growth. A surgical defect of the left ninth rib was seen. Roentgenograms of the extremities revealed periosteal proliferation of the tibiae, fibulae and the third, fourth and fifth metacarpals, due to hypertrophic pulmonary osteoarthropathy. Bronchoscopy was performed and a partial obstruction of the left main bronchus was found. It was thought the patient had an inoperable carcinoma of the left lung. He was discharged and died two months after leaving the hospital.

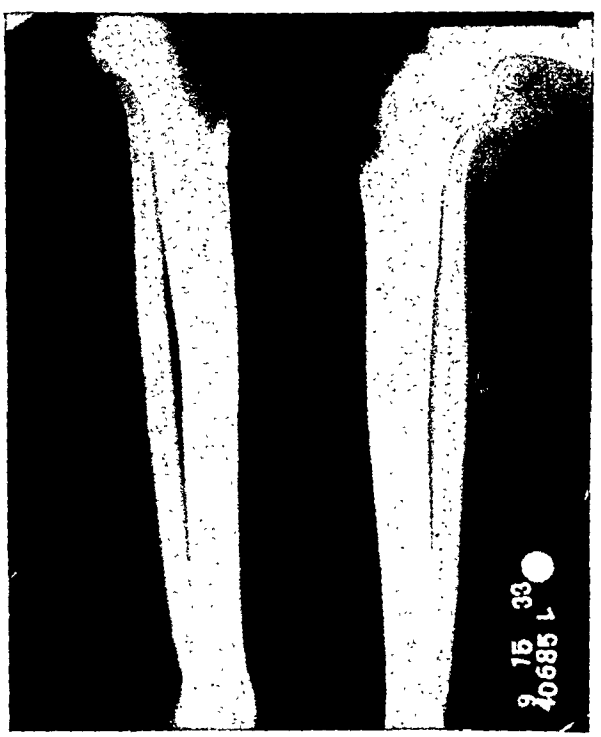


Fig. 10. Case v. Both bones show periosteal proliferation.

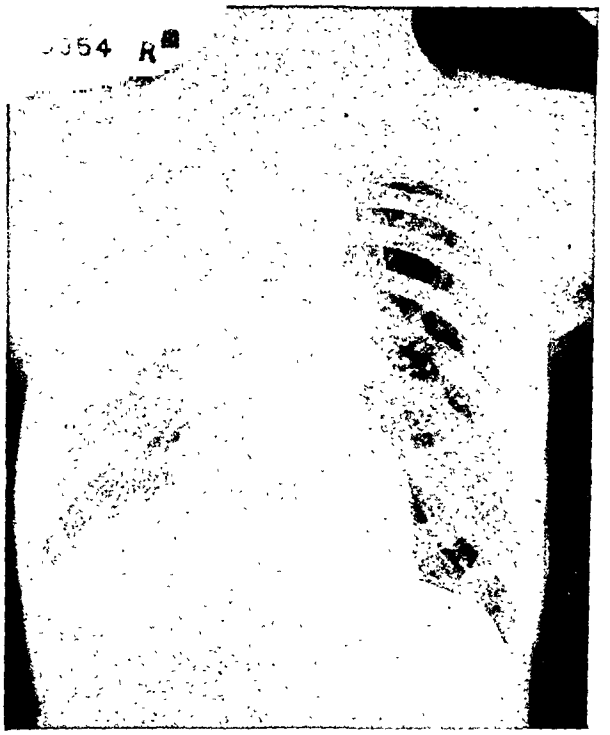


Fig. 11. Case vi. There is a large round dense shadow which increased in size despite all forms of therapy.

Case vi (Fig. 11 and 12). D. K., male, aged seventy-three. The patient was first seen in 1932 complaining of pain in the left shoulder and swelling of the hands and ankles. The pain had started two months before and was associated with weakness and tiredness. He was admitted to another institution because of pain in the extremities and joints. A chest roentgenogram showed a large mass in the right upper lobe. Biopsy was refused. He was uncooperative and, after receiving an undisclosed amount of roentgen therapy, he was discharged. The pain in the bones and joints was interpreted as



FIG. 12. Case VI. There was clubbing of the fingers. The periosteal new bone formation is best seen along the proximal phalanges.

metastases. On admission to the New York Hospital, the patient had pain in the right chest, knees and ankles. Just previous to admission there was occasional bood-streaked sputum. There was considerable weight loss. On examination, tenderness was present over the right upper lobe. Breath sounds were distant. There were rales at the right base. The distal phalanges showed early clubbing. There was edema of the feet and lower legs. A chest roentgenogram revealed a large, round, fairly well circumscribed shadow in the right mid-lung field, approximately 7 cm. in diameter. Later films showed gradual enlargement of the mass. Roentgenograms of the hands showed evidence of periosteal proliferation along the proximal phalanges of the hands suggesting hypertrophic pulmonary osteoarthropathy. Further deep roentgen therapy was given to the right chest, but the patient became progressively worse and was discharged to a home for terminal care.

CASE VII. J. H., male, aged thirty-seven, was first seen because of pain in the right shoulder. This had started ten weeks before admission and was associated with slight cough and sputum. The pain gradually increased in intensity, and required narcotics for relief. Drooping of the right lid occurred with increased sweating on the left side. Clubbing of the fingers and toes was noted during this interval. On physical examination the patient appeared to be acutely ill and showed evidence of marked weight loss. There was ptosis of the right lid with right-sided anhidrosis. There were no abnormal findings in the chest. The extremities showed marked clubbing. A chest roentgenogram showed a homogeneous density within the circle of the right first rib. The inferior portion of the fourth rib showed destructive change. The impression was that of a bronchogenic carcinoma. The long bones showed minimal periosteal new bone formation involving the radii, tibiae, fibulae and left ulna. Bronchoscopy was negative.

A pneumonectomy was performed and resection of portions of the right third, fourth and fifth ribs were done. The pathological diagnosis was pleomorphic carcinoma of the right upper lobe. The patient received roentgen therapy postoperatively. A total of 2,400 r, measured in air, was given to the right chest posteriorly. The patient was then discharged.

CASE VIII (Fig. 13 and 14). J. P., male, aged fifty-four, came to the clinic complaining of pain in the chest and legs of nine months' duration. The symptoms first started with a stabbing pain in the left chest which radiated both anteriorly and posteriorly. This gradually increased in intensity. Appetite was poor. There was a sensation of pressure in the chest. The pain then began to radiate down the left arm, and the left hand swelled. The finger nails became curved. The left knee and ankle were very painful and then both left extremities were weak. About a month before admission the right hand showed changes similar to the left. There was a 40 pound weight loss. Examination showed the patient to be chronically ill. The teeth were dirty and carious. Gingivitis was present. The lungs were clear. The breath sounds in the left paravertebral between the fourth and sixth dorsal vertebrae. The spine was tender between the first and fourth dorsal vertebrae. The sounds were distant. No murmurs heard. Bilateral inguinal hernias were present. The extremities showed marked club-

bing of the fingers and toes, with involvement of the hands and feet. A chest roentgenogram revealed increased markings suggesting bronchiectasis with pulmonary emphysema. A curvilinear calcium line was seen in relation to the left hilum. A second chest roentgenogram made three days later was interpreted as an air-filled cavity adjacent to the left hilum with a calcified shell—probably a bronchogenic cyst. Roentgenograms of the upper extremities showed typical changes of periosteal bone proliferation. Barium enema and gastrointestinal series were reported as negative.

The patient was seen by an ear, nose and throat consultant who found fixation of the left vocal cord. Bronchoscopic examination showed edema of the main bronchi. There was no evidence of a tumor. Urological findings were normal. During the latter part of his stay, the patient developed a left upper lobe pneumonia which responded to chemotherapy. Because of persistent chest pain, a course of deep roentgen therapy was tried; 1,600 r, measured in air, was given to two portals without effect. He was discharged but failed to return for follow-up. The case remained undiagnosed but was thought to be a bronchogenic cyst.

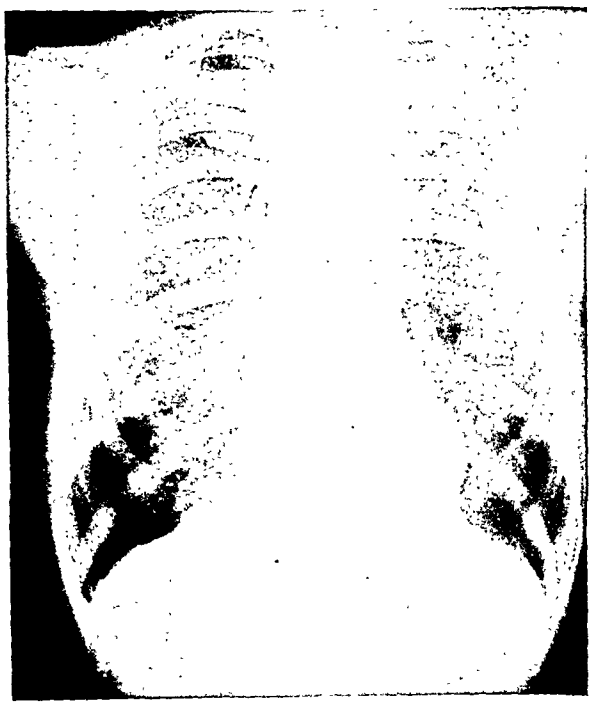


Fig. 13. Case viii. There is bilateral pulmonary emphysema. The markings are increased, suggesting bronchiectasis. A curvilinear calcium line is seen adjacent to the left hilum. It was interpreted as a bronchogenic cyst.



Fig. 14. Case viii. The periosteal proliferation involves mainly the metacarpals.

Case ix. J. H., male, aged fifty-one, was first seen in the clinic in 1933, complaining of weakness and swelling of the ankles and poor appetite. He had these symptoms since 1929, for which he had been admitted to another hospital. His case was diagnosed as Addison's disease and chronic pulmonary tuberculosis. He improved and was asymptomatic until 1933, when his symptoms returned. The weakness was associated with a weight loss of 20 pounds, and stiffness of the knees and ankles. There was moderate dyspnea on exertion. The fingers had always been clubbed. While being observed in the Out-Patient Department, a lump was noted in the left breast. He went to a city hospital and a radical mastectomy was performed. No report was received from this institution as to their findings.

On physical examination, the patient presented marked emphysema of the chest. There were a few rales at the left base. The left

breast was absent. There were no murmurs. The extremities showed clubbing of the fingers and toes. The ankles were very large. The ankle joints were stiff.

Roentgenograms of the chest revealed old, bilateral, apical scarring. There was no evidence of scarring. Bronchography showed a small area of bronchiectasis in the posterior left lung field. The roentgenograms of the long bones showed generalized, periosteal proliferation indicating the presence of hypertrophic, pulmonary osteoarthropathy.

The patient was discharged to be followed in the Pulmonary Clinic. He showed no improvement over several years and was lost sight of. It was later reported that he died in April, 1940.

Case x (Fig. 15 and 16). V. G., male, aged sixty-eight, was referred to the Out-Patient

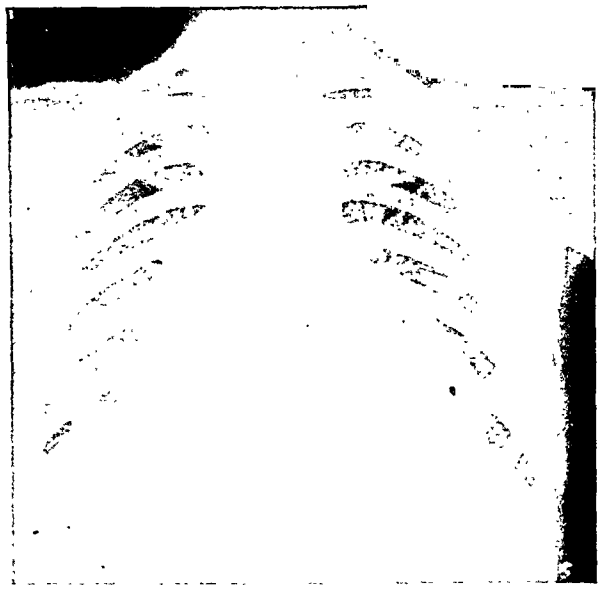


Fig. 15. Case x. There is generalized enlargement of the heart with congestive changes. The lung parenchyma is clear.

Department by his local physician because of a markedly enlarged spleen and shortness of breath. Five years before admission, the patient had an attack of pneumonia, for which he was hospitalized at another institution. His blood count at that time showed the usual leukocytosis, but there was no evidence of abnormal cells. In 1941 he again entered another hospital where he was again treated for a pneumonia and hypertensive heart disease. Blood counts were consistent with the usual changes in a pulmonary infection. It was about this time that he first noted a mass in the upper left quadrant. He was first seen in the Out-Patient Department of the New York Hospital in January, 1942, complaining of dyspnea, weakness, palpitation and edema. The liver and spleen were found to be enlarged. The blood count was that of a chronic myelogenous leukemia. The total white blood count was 100,000. Differential showed 5 per cent lymphocytes, 1 per cent monocytes, 4 per cent eosinophiles, 4 per cent basophiles, 9 per cent mature polymorphonuclears, 35 per cent band forms, 16 per cent metamyelocytes, 11 per cent myelocytes, 12 per cent promyelocytes, 5 per cent myeloblasts. Hemoglobin 52 per cent. Red blood cell count was 3.75 million. Kline test was negative. Urine showed a 3 plus albumin. Smears for malaria were negative.

The physical examination showed marked generalized wasting. Hard, shotty nodes were present in the axillary, inguinal and posterior cervical regions. The heart was enlarged and systolic, apical murmurs could be heard. The spleen was tremendously enlarged and reached well into the pelvis. The liver was palpable 4 fingerbreadths below the right costal margin.

A chest roentgenogram was reported as marked, generalized cardiac enlargement with congestive changes. A film of the right femur showed a thickening of the periosteum due to chronic pulmonary osteoarthropathy.



Fig. 16. Case x. The entire periosteum is thickened.

The patient was given three series of deep roentgen therapy over the spleen, resulting in a considerable reduction in the size of the spleen. He improved after each course, but the symptoms recurred. He ran a gradually retrogressive course but eventually did not return to the clinic.

Case xi (Fig. 17 and 18). W. D., male, aged forty-nine, entered the hospital because of diarrhea and cramps of six months' duration. His first symptoms had occurred six months before admission with an attack of diarrhea, cramps and malaise lasting about three days. There were four to five loose stools daily. Several months later the same symptoms recurred and had been present ever since with copious, watery, foul stools which were brown in color. There was a 50 pound weight loss. A month before admission, swelling of the ankles occurred, associated with extreme weakness.

Physically, the patient showed considerable emaciation. His blood pressure was 100/74. There was arteriosclerosis and the fingers and toes were clubbed and cyanosis of the nail beds was present.



Fig. 17. Case xi. The small intestinal pattern following a barium meal is definitely abnormal. It shows clumping and dilatation and a loss of the feathery appearance indicating the so-called dietary deficiency pattern.

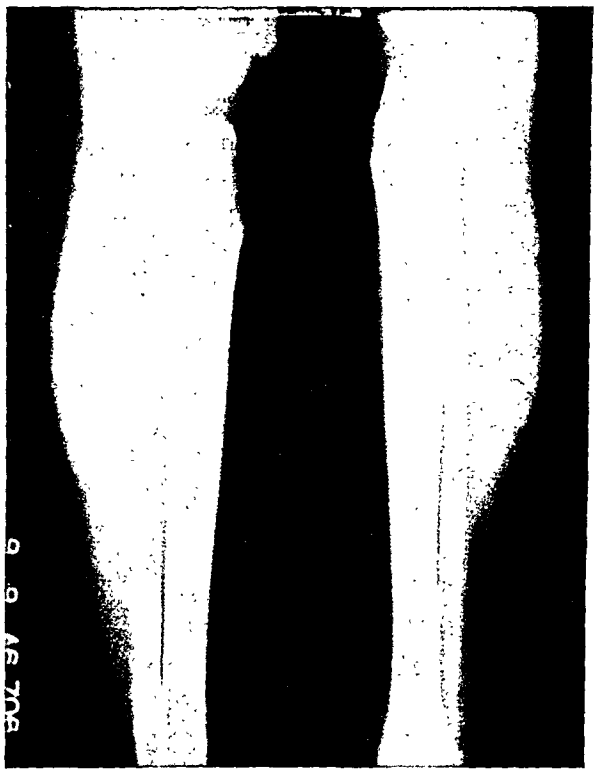


Fig. 18. Case xi. The periosteal proliferation is best seen involving the fibula.

A roentgenogram of the chest at the time of admission was reported as negative. Roentgenograms of the extremities showed slight demineralization of the femora and humeri. There was no periosteal proliferation at this time. Barium enema was negative. A gastrointestinal series showed a normal esophagus, stomach and duodenum. The small intestinal pattern was definitely abnormal. It showed the clumping, dilatation and loss of valvulae conniventes, described as the dietary deficiency pattern. After a month of intensive therapy consisting of a high caloric, low fat diet with folic acid, heavy doses of vitamin A and D and calcium lactate, the patient showed clinical improvement. Re-examination of the small intestine showed an improved pattern. However, roentgenograms of the extremities revealed extensive hypertrophic osteoarthropathy of the femora, tibiae and fibulae with demineralization. The upper extremities and feet showed similar changes. The chest roentgenogram was still reported as negative. About six weeks later, re-study of the extremities presented evidence of periosteal proliferation involving the femora,

tibiae and fibulae. Improvement had occurred in the other bones and these were reported as normal. This corresponded to the clinical improvement of the patient, although a small intestinal study still showed some abnormality of the intestines.

Stool cultures were consistently reported as negative throughout the entire illness. The blood count showed no abnormality except for a moderate anemia. Gastric analysis showed no free hydrochloric acid.

The patient was discharged in an improved condition with a diagnosis of non-tropical sprue. He is still being followed in the clinic and apparently further improvement is gradually occurring.

DISCUSSION

The presence of joint symptoms in previously healthy individuals should be carefully evaluated in order to determine the possibility of a co-existing underlying pathological condition. In 8 of these cases an associated disease was present which first manifested itself by painful or swollen joints. Roentgenographic examination of the joints led to the discovery of periosteal new bone formation with subsequent investigation establishing the proper diagnosis. Six of these cases were definitely proved cancers of the lungs, the most common being bronchogenic carcinoma. In 2 other cases, the diagnosis was almost certainly a lung malignancy but positive pathological proof could not be obtained. Case VIII was undiagnosed, but the roentgenogram showed pulmonary abnormality. In only 2 of our series was the primary disease outside of the respiratory tract. One of these was a chronic myelogenous leukemia with generalized adenopathy. It is quite possible that the mediastinal nodes could have been involved. The other was a case of non-tropical sprue. In practically all the cases of this series, an improvement in the primary disease was associated with an improvement in the symptomatology secondary to the hypertropuic pulmonary osteoarthropathy.

SUMMARY AND CONCLUSION

1. Symptoms of joint pain and swelling simulating arthritis may be due to hypertrophic pulmonary osteoarthrophy.

2. Roentgenologic demonstrations of periosteal new bone formation should lead to further investigation of the underlying primary disease.

3. The most common site of the primary disease is within the pulmonary tract, although other systems may be involved. The most common condition is malignant growth of the lung.

4. The etiology of hypertrophic pulmonary osteoarthropathy has not as yet been definitely determined.

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SCLEROSIS OF BONES IN GAUCHER'S DISEASE*

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BONE changes in Gaucher's disease are generally considered as destructive lesions. Their progress is slow. Their roentgenological appearance is characterized by mottling and rarefaction of bone structures and expansion and deformity of the bones involved. The cortex of long bones may become thinner because of erosion of the inner layers induced by proliferating Gaucher cells. Absorption from the inside and accretion on the outside produce the characteristic club-shaped or fusiform widening "Erlenmeyer flask" deformity of the shaft of the femur. Further abnormalities are changes of shape and structure of the head of the femur with softening of the neck, collapse of vertebral bodies with gibbus, pathological fractures, and others.

While roentgen signs of these abnormalities and their patho-anatomical fundamentals have often been discussed, very little attention has been directed toward proliferative bone changes. Although several investigators maintain that mottled areas of bone erosions may alternate with condensation,[1,2,3,5,7] and bone destruction may be intermingled with areas of sclerosis, on the whole, pathological ossification has not been considered as an integral feature of osseous manifestations of the disease.

We had the opportunity to study bone changes in 2 cases of Gaucher's disease and

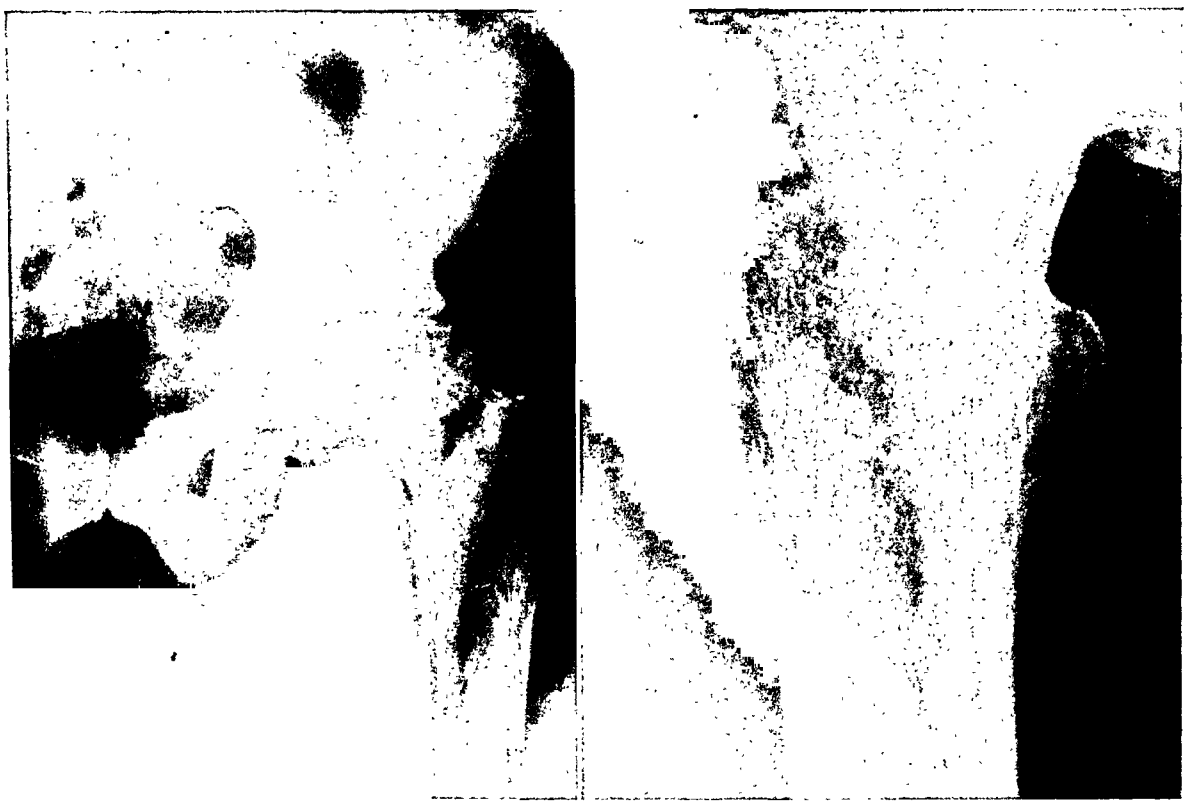


FIG. 1. The patient (No. 31799) was a male, aged fifty-two, with Gaucher's splenomegaly. Roentgenograms show deformity of the head of the left femur with translucent areas surrounded by densities. Bone cylinder in medullary cavity seen below trochanters.

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found that in both more or less marked new formation of bone tissue was recognizable. A third case that came to our attention also showed similar findings.

Our first patient was under observation for twenty-four years. The first beginnings of bone changes were hypertrophic fringes around the left acetabulum and faint mottlings of the structure of the head with signs of condensation. The case was interpreted during the first seven years as being a low grade infectious arthritis with regenerative bone changes. Later bone tissue was laid down in the intertrochanteric area, and finally a hollow bone cylinder developed inside the medullary cavity, running parallel to the cortex from the trochanters to the middle of the shaft of the femur, occupying the peripheral portions of the marrow (Fig. 1). In the distal portions of the femur diffuse bone formation prevailed intermingled with faint translucent areas (Fig. 2). The case was verified at a laparotomy made for removal of gallstones.

Similar "bone cylinders" were seen in the marrow cavity of both femora in another instance of the disease occurring in a young soldier. The roentgenograms of this case were presented at the San Francisco

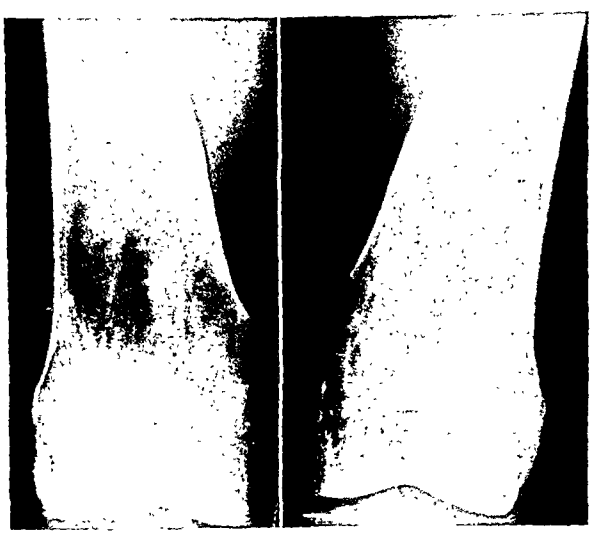


Fig. 2. Same patient as in Figure 1, showing diffuse bone formation in medullary cavity of the lower left femur.

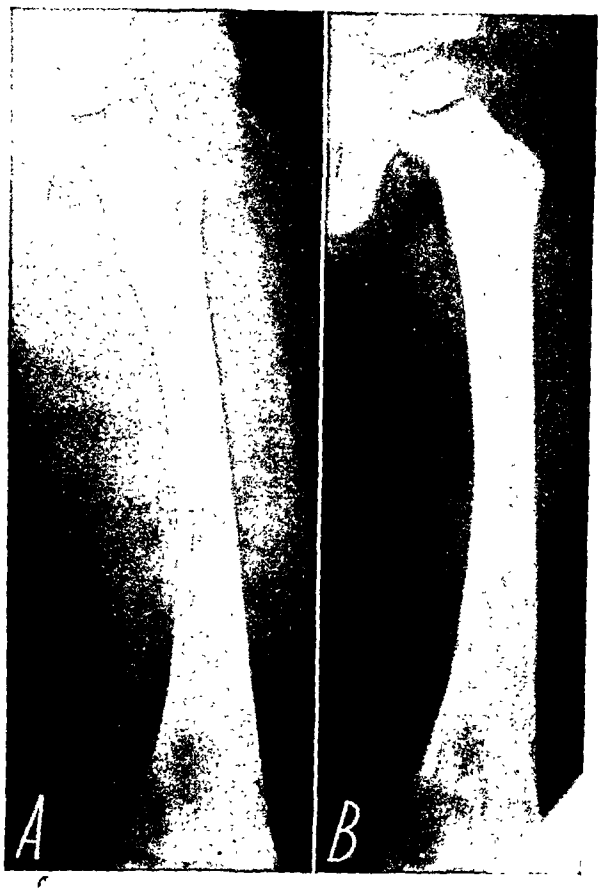


Fig. 3. The patient (No. 239849) was an Indian boy, aged two, with splenomegaly. *A*, normal appearing left femur in Gaucher's disease. *B*, same femur eight months after splenectomy revealing thickening of the cortex with signs of faint diffuse bone formation in the medullary cavity.

X-Ray Study Club in 1944. They revealed fusiform expansion of the distal half of both femora. Bands of ossification were seen running parallel to the cortex in the medullary space. They had the width of approximately 5 mm. on each side and were separated from the inner aspects of the cortex by a space, measuring approximately 1 or 2 mm. They extended almost the length of the femur. The disease was verified histopathologically after splenectomy. Further data on this patient are not at hand.

In our second case, the disease was observed in two year old Indian boy. The first roentgen survey showed a normal skeleton. Both femora revealed no abnormal findings (Fig. 3*A*). Eight months later, however, following surgical removal of the

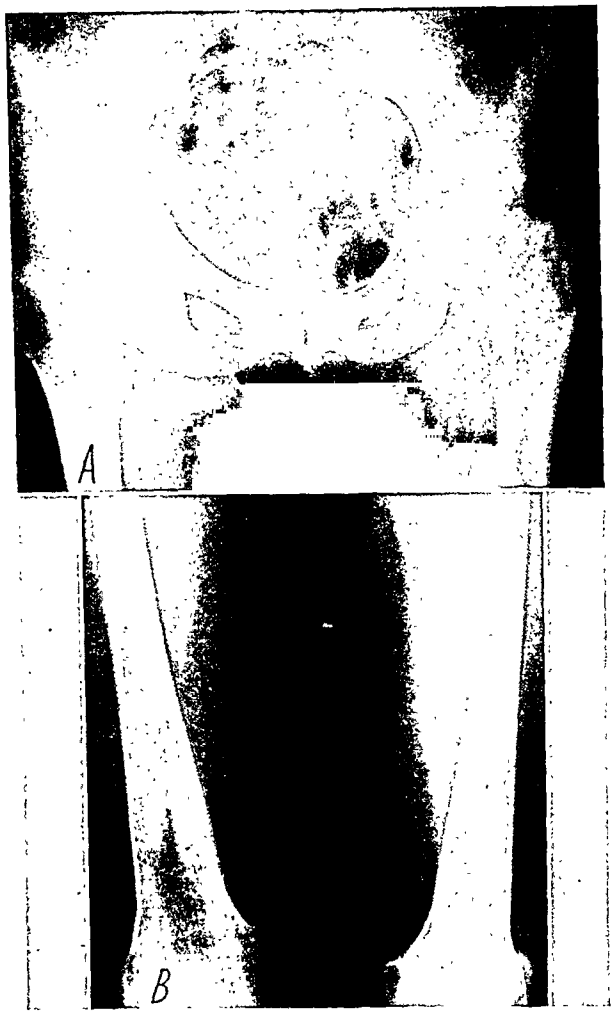


Fig. 4, *A* and *B*. The patient (No. 239549) was a female, aged fifty-six. Roentgenograms show pathological fracture of the neck of the left femur with numerous translucencies about the fracture and in the intertrochanteric area. Absence of bone sclerosis makes Gaucher's disease unlikely, despite Erlenmeyer flask deformity of shaft of femur. Autopsy diagnosis: hemocytoblastic myeloma.

enlarged spleen, thickening of the cortex of the right femur and signs of faint pathological ossifications were exhibited in distal portions of the marrow cavity (Fig. 3*B*). We explained this remarkable event by assuming that proliferations of Gaucher's structures were already present in the marrow prior to splenectomy. At that time they produced no roentgen signs. Appearance of ossifications eight months after removal of the spleen indicated that in the meantime the Gaucher proliferations had undergone retrogressive changes which were associated with bone formation.

The process of osteogenesis in Gaucher's disease was first described by Pick. He found that the argentophile reticulum produced by cells of reticulo-endothelial hyperplasias becomes transformed into collagenous structures, while the specific cells themselves gradually disappear. They are replaced by dense, sclerotic connective tissue. Bone formation takes place as a direct metaplasia of connective fibers and not by osteoblastic activity. Consequently newly formed bone spicules are not the products of the osteogenic mesenchyma. Similar observations were made by us[11] in leukemic forms of reticulo-endothelioses (monocytic leukemia).

It seems that ossifications in the bone marrow in cases of Gaucher's disease are not incidental findings. They are tissue products of reticulo-endothelial proliferations developing as direct osseous metaplasias of reticular and collagenous fibers. These in turn are contributed by the reticular cells themselves, mainly as replacements of degenerating and aged cells.

Despite the fact that no attention has been paid until now to sclerotic changes in Gaucher's disease, sclerosis of bones is recognizable on roentgenograms illustrating several articles (ref. 4, Fig. 3 and 8), (ref. 5, Fig. 5), (ref. 6, Fig. 1), (ref. 9, Fig. 6), (ref. 10, Fig. 4), and others. It is conceivable that no signs of pathological bone formation will be exhibited in early skeletal manifestations of Gaucher's disease. In such cases probably only the absorptive or destructive phases of bone changes are manifest, and the productive phase is held in abeyance. The late appearance of bone formation in spongy structures adjacent to bone erosions may be misinterpreted as signs of reactions of osseous regenerations in the vicinity of inflammatory lesions. This is probably the reason why the similarity of bones in Gaucher's disease to those of osteomyelitis and chronic tuberculosis is not infrequently recorded.[8]

In our second case pathological ossification in the bone marrow became visible in a child as soon as eight months after splenectomy. In connection with the above considerations we have to assume that removal of the spleen influenced the vitality of Gaucher cells in the bone marrow. It probably caused retrogressive changes which were associated with development of fibrous structures. These in turn formed the ossifications seen on the roentgenograms. Although splenectomy is no "cure" in Gaucher's disease, the consensus is that removal of the spleen usually improves the clinical condition of the patient. This is due not only to physical factors but also to immediate improvement of blood formation, sudden increase of platelets in the peripheral blood, decrease of bleeding time, and so forth, as was observed in our case also.

Recently we had the opportunity to see the Erlenmeyer flask deformity in the middle and distal portions of the right femur in the case of a woman, aged fifty-six. We considered this sign to be indicative of Gaucher's disease. The patient had been suffering for several months from a pathological fracture of the neck of the femur. The bone structure was mottled in the surroundings of the fracture and also in the head and in the intertrochanteric areas. No signs of bone formation were exhibited however, in structures adjoining the mottled areas of the femur or in the marrow cavity of the expanded shaft during the one and one-half years of observation. Autopsy revealed that bone changes were caused not by Gaucher's disease but by the rare disorder of hemocytoblastic myeloma (Fig. 4, *A*, *B*).

Absence of ossification in this case, in which all other roentgen signs were characteristic of Gaucher's disease corroborates our belief that ossifications in the medullary cavity and in spongy structures are integral findings in advanced cases of this disorder.

SUMMARY

Attention is called to the frequent presence of roentgenological signs of bone formation in the medullary cavity in cases of Gaucher's disease. The new formation of osseous tissue is not excessive and is similar in appearance to regenerative ossification in the surroundings of inflammatory lesions. They occur, however, not only in bone structures adjoining absorptive changes but also in such parts of the medullary cavity in which no roentgenological signs of bone destruction are exhibited. In two of our observations bone cylinders were present and occupied the peripheral portions of the medullary cavity in the proximal two-thirds of the femur.

Bone tissue is laid down in such cases in intercellular fibrous structures of Gaucher proliferations as a product of direct metaplasia of collagenous fibers. Such fibers are in abundance in late stages of the disease. Consequently, the presence of ossifications in the medullary cavity or in spongy areas indicates localized or general ageing of the pathological tissues. In early manifestations no appreciable amount of fibers is formed. Therefore, pathological osteogenesis may be absent.

Roentgen signs of pathological ossification in Gaucher's disease may be of diagnostic significance. This occurs if newly formed bone tissue is laid down in areas situated about absorptive lesions and involves simultaneously more remote areas of the medullary cavity in which no destructive changes are evident.

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A CASE OF LONG STANDING SICKLE CELL ANEMIA WITH MARKED BONE CHANGES*

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SICKLE cell anemia can be classified among the chronic hemolytic anemias. It is a hereditary disease first described by Herrick[3] in 1910 and exclusively limited to persons of Negro ancestry. It is important to distinguish between individuals suffering from "sickle cell anemia" and those just bearing the "sickle trait." The latter is a dominant asymptomatic finding in about 5 to 10 per cent of American or West African Negroes. Person afflicted with sickle cell anemia usually do not live beyond the age of thirty. They die in early life from intercurrent infection, vascular thrombosis or uremia, thus limiting the propagation of the disease.

CLINICAL PICTURE

Sickle cell anemia is characterized by attacks of excessive blood destruction resulting in anemia, pallor, icterus, weakness, shortness of breath, joint and abdominal pains, splenomegaly, hepatomegaly, chronic leg ulcers, and gallstones. Between attacks there may be few or no symptoms. The increased demand upon the hematopoietic system results in increased medullary activity. This hyperactivity of the bone marrow produces the characteristic roentgenographic skeletal changes.

ROENTGEN FINDINGS

Few papers have appeared dealing with the roentgen findings occurring in sickle cell anemia since the excellent review by Caffey[1] in 1937. He pointed out that the appearance time of the first detectable roentgen changes following the clinical appearance of the disease varies considerably. In 1941 Danford, Marr and Elsey,[2] described a case of sickle cell anemia in an eight month old Negro infant who already presented roentgen evidence of bone changes. The lesions were stated to have disappeared after repeated blood transfusions and generally improved health of the infant.

CASE REPORT

The patient is a female, married, aged forty-three, referred by Dr. Barrett to the Salt Lake County General Hospital with the diagnosis of "sickle cell anemia."

Past History. She stated that she had had joint pains in her arms and legs throughout her life. Splenomegaly was observed when she was three years old and has been present off and on ever since. Her teeth did not erupt until she was nine years old and when they finally appeared they were crooked, malformed and had to be extracted. A plastic repair was done on the gums. During the past ten years she has been suffering from chronic recurrent leg ulcers, increasing deafness and monthly episodes of epistaxis independent of the menstrual cycle. There is a history of irregular menstruation with no real cycles. The bleeding lasts from one to three weeks and is quite profuse without dysmenorrhea. There has never been any purpura. Attacks of generalized abdominal pain have occurred since the age of sixteen.

She has never been pregnant though no contraceptives have ever been used. In 1943, a bilateral salpingectomy (endosalpingitis), removal of ovarian cyst, uterine suspension and appendectomy were performed at another hospital.

Rheumatic heart disease was diagnosed at the age of nine and digitalis taken intermit-

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tently since then. During the past few years she has developed mild pitting edema of ankles. Weakness, tiredness and anorexia have been prominent as long as she can remember. In spite of this she has been doing housework and working as a sales clerk. Several years ago she was told that she was suffering from an anemia "which probably came from her Negro grandfather."

Family History. Her father is half Indian and half white. He died of "dropsy" at the age of forty-five. Her mother is half Mexican and half Negro, aged seventy and well. Five siblings are living and well. There are no other known cases of sickle cell anemia in the family.

Physical Examination. The patient is a slender, chronically ill looking woman who bears many negroid facial features. The physical examination is not remarkable except for the following: There is bilateral middle ear deafness. The drums are normal.

Heart: The point of maximal impulse is 12 cm. from the mid-sternal line in the fifth left intercostal space. The right heart border is 3 cm. from the midsternal line in the fifth intercostal space. The rhythm is regular, the rate 80. A rough systolic murmur is heard over the apex.

Abdomen: There is an old, well healed midline incisional scar. The liver can be palpated 4 cm. below the costal margin. Rectopelvic findings suggest uterine myomas.

Extremities: There is shallow, clean granulating ulcer measuring 4 by 5 cm. on the medial aspect of the lower right leg and evidence of old scars on the left leg.

Laboratory Data (see Table 1).

Blood smear: Anisocytosis, poikilocytosis and basophilic stippling 1 to 3 plus. Hypochromasia—1 plus. Twenty to 31 nucleated red cells. Fresh preparation shows 95 per cent sickling.

Van den Bergh test:

One minute (direct 1.08 mg.)
(normal 0–.25 mg.)
Thirty minutes (total 1.22 mg.)
(normal to 1.2 mg.)

Stool: 9,000 Ehrlich units urobilinogen. Guaiac test negative.

Gastric analysis: No free acid after histamine. Urine urobilinogen normal.

Electrocardiogram. Normal.

TABLE I

LABORATORY DATA

	Normal	October 21, 1946	November 7, 1946
Leukocyte count	5–10,000	15,000	23,000
Juveniles	3–5%	1%	10%
Polymorphonuclears	54–62%	57%	62%
Eosinophiles	1–3%	4%	4%
Lymphocytes	25–33%	28%	18%
Monocytes	3–7%	10%	6%
Red blood cell count	4.2–5.4 million	3.4 million	2.09 million
Hemoglobin	12–16 gm.	8 gm.	5 gm.
Hematocrit	34–47	23	15
Mean corpuscular volume	82–92	67	71
Mean corpuscular hemoglobin	27.31	22	24
Mean corpuscular hemoglobin concentration	32–36	34	33
Reticulocytes	0.5–2%	15%	13%
Icteric index	4–6	30	75
Erythrocyte sedimentation rate	0–15	3	67 uncorrected
Bleeding time	1–5 min.	2 min.	1 min.
Clotting time	2–5 min.	3 min.	
Clot. retr.	2–3 hr.	1 hr.	1 hr.
B.U.N.	8–15 mg. per 100 cc.	21	23
Calcium	9–11 mg. per 100 cc.	11.4	
Phosphorus	3–4 mg. per 100 cc.	4.2	
Kahn test		Negative	
Fragility test	.30–.36% NaCl	.18% NaCl	

Roentgen Findings.

Posteroanterior roentgenogram of the chest: The lung fields are clear. The transverse diameter of the cardiac silhouette is at the upper limits of normal. There is a calcific plaque in the knob of the aorta.

Skull roentgenograms (anteroposterior, lateral (Fig. 1) and basal views): The findings here are very unusual in that the bones of the vault are extremely thick. It is impossible to delineate the tables because of the increased density of the calvarium. The frontal sinuses are large and well aerated. The mastoids in contradistinction show an almost complete lack of pneumatization. There is an irregular defect in the left parietal bone measuring 1.5 by 2 cm. This has a sclerotic margin.

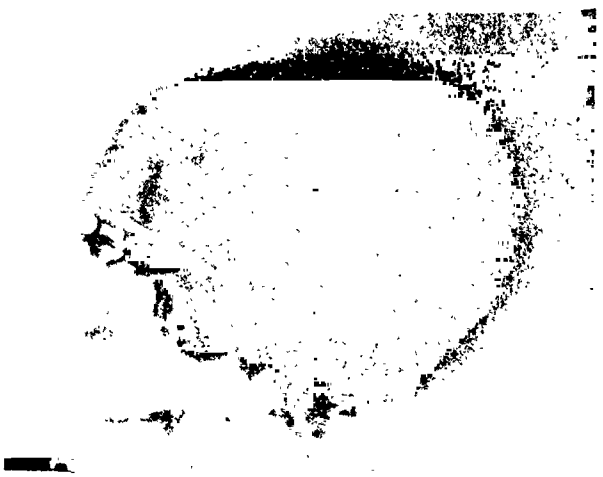


Fig. 1. Skull (lateral view). There is absence of delineation of the tables. The bones are dense and and sclerotic. The mastoids have failed to pneumatize.

Posteroanterior roentgenogram of both hands: There is almost complete loss of the trabecular pattern of the shafts of the metacarpals and phalanges. The cortex is markedly thickened. The second phalanx of the middle finger and the fifth metacarpal bone of the right hand show cyst-like areas within the medullary cavity with expansion of the shafts.

Extremities (Fig. 2 and 3): Both fibulae and ulnar bones show cortical thickening. In some areas there is widening and increased trabeculation of the medullary cavity with concomitant thinning of the adjacent cortex. There is marked variation in density suggesting cyst formation. The upper third of the left tibia shows marked overgrowth of the cortical bone so that it encroaches upon the medullary cavity.

Roentgenogram of right upper quadrant (Fig. 4). There are numerous facetted and laminated calculi outlining the gallbladder. There is a solitary stone at the level of the first lumbar intervertebral disc which may be in the cystic duct.

DISCUSSION

This case shows many of the typical features of sickle cell anemia. There is a history of splenomegaly intermittently for forty years. The liver is at present enlarged. Rheumatic heart disease was diagnosed at one time because of the migrating joint pains, the abdominal pains, the heart murmur and the leukocytosis. This is a frequent diagnostic error. Many of these cases are



Fig. 2. Lower extremity (lateral view). There is localized thickening of the cortex of the upper third of the shaft of the tibia. This appears to encroach upon the medullary cavity.

also mistakenly diagnosed as acute abdominal emergencies and operated on. The diagnosis can be made by examining a wet blood smear preparation for evidence of sickling. When dealing with the "sickle trait," sickling may not appear for six to twenty-four hours, whereas in sickle cell anemia it shows up in thirty minutes to a few hours.

Chronic leg ulcers, gallstones and epistaxis as seen here are frequent in persons

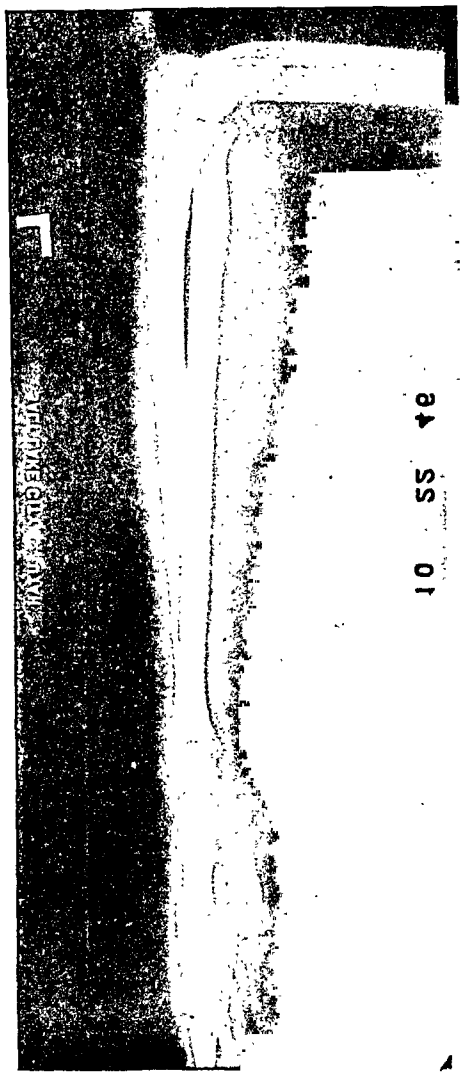


Fig. 3. Forearm (lateral view). There is irregular thickening of the cortex. The architectural pattern shows some increase in trabeculation.

suffering from sickle cell anemia as well as other chronic hemolytic anemias.

The bone changes that develop apparently depend on the degree of strain placed on the hematopoietic reservoir. That is why they are probably rarely described in young children. Most authors agree that the skull changes are similar to but less pronounced than those observed in erythroblastic anemia. They usually find widening of the tables of the vault associated with vertical striations. Thickening of the diploe results with loss of definition of the outer table.

Changes in the long bones seem to be less frequent. Usually the cortex is thickened as opposed to thalassemia in which it is thinned. Osteosclerosis and new bone formation within the medullary cavity



Fig. 4. Right upper quadrant. There are numerous facetted and laminated calculi outlining the gallbladder.

have been reported. At times this is associated with scattered translucent areas.

The combined cortical thinning and thickening such as seen in the case reported here have not been noted in other cases. The involvement of the whole calvarium including the mastoids by an osteosclerotic

process rather than the "hair on end" striations is unusual. Previous publications do not mention the increased reticulation in the flat and short bones nor the cystic areas noted in the tubular bones of the hand such as are present in this case.

SUMMARY

A case of long standing sickle cell anemia is described, showing unusual roentgen changes in the skull, tubular and flat bones.

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DIVERTICULOSIS OF THE GALLBLADDER

CASE REPORT

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SINCE Bársony's original report of a single diverticulum of the gallbladder, confirmed by operation, similar cases have been sporadically recorded in the literature by other writers. The roentgenologic features of these diverticula have also been described by Vastine, Paillard and Paillard, and by Hartmann. Diverticulosis of the gallbladder seems to escape roentgenologic detection completely and, according to Weisel and Walters, is almost exclusively recognized at operation or on pathological examination.

Recently we had the opportunity to observe a patient with cholelithiasis associated with diverticulosis of the viscus, demonstrated by cholecystography. It may therefore be justified to report this case and to present a brief discussion of the subject.

The problem of pathogenesis of gallbladder diverticula, and, more particularly, their relation to other diseases of the gallbladder has been the subject of extensive clinical and pathological studies. Rokitansky, who first described hernia-like outpouchings of the gallbladder mucosa, noted that they frequently contained small stones completely separated from the lumen of the viscus. Aschoff was convinced that diverticula, which he confused with Luschka's ducts, played an important role in the pathogenesis of cholecystitis and cholelithiasis, with which they are commonly associated. He suggested that prolonged stasis and increased intracystic pressure within a diseased gallbladder caused a gradual increase in size of small crypts, encountered also in the walls of normal gallbladders, until they penetrated through the muscular coat and formed "false diverticula." These invaginations occurred usually along the path of vessels passing between muscle bundles of the vesical wall and often were the seat of small stones.

Halpert concurred with Aschoff that diverticula were more common in the presence of gallbladder disease, but was emphatic in drawing a distinction between these structures and "true Luschka's ducts," which he defined as aberrant bile ducts in no way related to diverticula. This author preferred to designate the latter as "Rokitansky-Aschoff sinuses," and stated that their development depended: (1) on the relative strength and development of individual muscle bundles and their relation to each other; (2) on the number and size of the blood vessels passing through the intermuscular spaces and their mode of penetration; and (3) on the state of contraction of the gallbladder and any condition, especially pathologic, which influenced its contractibility.

Experimental studies by Higgins, and Higgins and Mann, disclosed that, in guinea pigs, contractions of the gallbladder wall were rather isolated, independent and accompanied by formation of small herniations; no rhythmic peristaltic waves were observed. In 1923 Westphal demonstrated that neurogenic disturbances, causing a spasm of the sphincter at the terminal portion of the common duct simultaneously with strong contractions of the vesical wall, were capable of producing multiple diverticula. Clinical observations confirmed the existence of a similar symptom complex in man; the symptoms consist of biliary colics in the absence of cholecystitis or cholelithiasis and are now generally attributed to dyskinesia of the gallbladder, particularly when irregular contractions of the latter are demonstrated by cholecystography.

The high incidence of diverticula in indi-

viduals suffering from cholecystitis or cholelithiasis has been generally emphasized. Robertson and Ferguson reviewed this subject recently, and presented the results of their own investigation of 495 gallbladders, comprising 175 postmortem and 320 surgical specimens. They classified diverticula into three grades, depending on the depth of penetration of the vesical wall. In the first grade the crypts extended to the muscular coat; in the second grade the invaginations penetrated into the intermuscular lacunae, and in the third grade, the diverticula penetrated through the muscular wall into the underlying connective tissues, occasionally reaching the serosa. Normal gallbladders of this series contained few superficial diverticula. Gallbladders evidencing previous inflammation without gallstones showed diverticula classified as Grade 2 in approximately 70 per cent of the examined specimen. Occasionally these were partially or completely cut off from the lumen of the bladder and dilated into cysts. In some cases, typical gallstones lay within the closed off crypts, while in others, calculi could be expressed into the lumen through the communicating "ducts." All degrees of inflammation leading to abscess formation, complete obliteration of the epithelial cells normally lining the spaces, and even rupture into the periotoneal cavity or the liver, were also observed. There was no definite indication that gallstones contributed significantly to the frequency or number of demonstrable diverticula.

Robertson and Ferguson were in agreement with previous writers, who saw a similarity between diverticula of the gallbladder and those encountered in the intestinal tract and in the urinary bladder. The fact that diverticula of the gallbladder were more frequent and numerous in the older age group suggested to them that invagination of the mucosa followed abnormal pressures, exerted during stages of abnormal contractions or relaxations of the underlying muscle bundles of a constitutionally "weak" viscus. They, too, emphasized the significance of neurogenic dysfunctional states of the extrahepatic biliary system in the pathogenesis of diverticula, though they did not deny the possible significance of stones and chronic inflammation as an additional etiologic factor, chiefly due to obstruction and increased intracystic pressure.

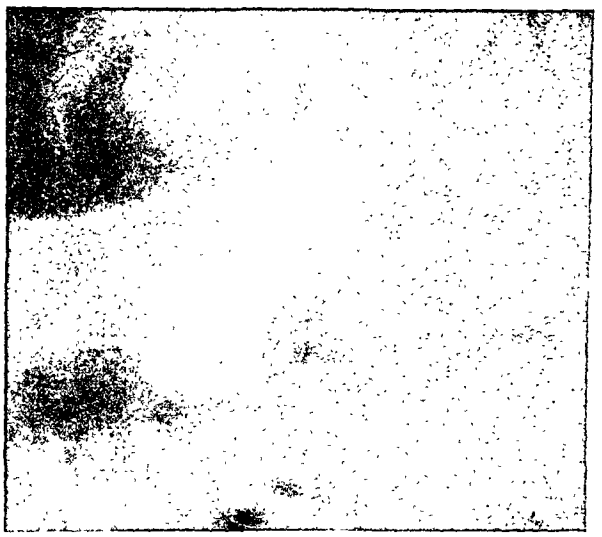


FIG. 1. Small sessile densities along the lateral wall of the gallbladder.

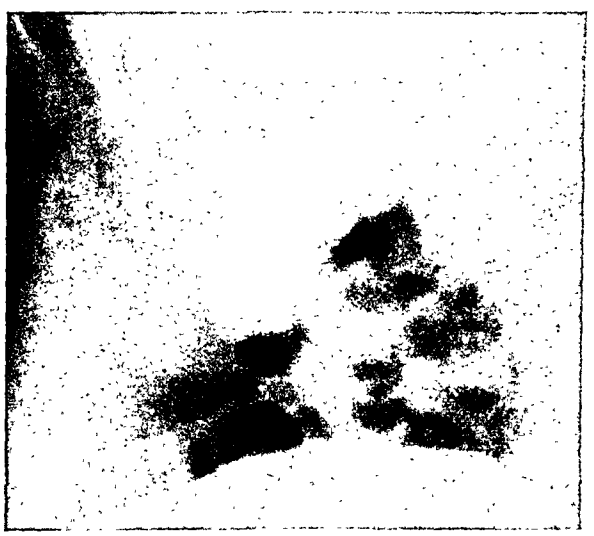


FIG. 2. The diverticula are clearly demonstrated after ingestion of fatty meal.

CASE REPORT

A middle aged, white female complained for several years of pain in the epigastrium, ag-



Fig. 3. Non-opaque stone near the neck of the gallbladder.

gravated by food containing fat. The symptoms were not severe and were usually relieved by an adequate diet. There was no history of colic or jaundice. The stools were not discolored. The patient was not hospitalized, but a routine roentgen examination of the gallbladder was made as a part of a medical examination.

The cholecystograms revealed a well visualized gallbladder, of normal size and in normal position. There were numerous diverticula arising from the walls of the gallbladder, which protruded beyond the outline of the viscus. Short "ducts" connected the diverticula with the bladder wall. One non-opaque stone was present within the lumen of the gallbladder. There was good contraction of the organ and concentration of the dye after fatty meal. A diagnosis of cholelithiasis and diverticulosis was made and cholecystectomy was advised.

COMMENT

Although, pathologically, diverticulosis has been shown to occur frequently in diseased gallbladders, it is seldom demonstrated roentgenologically. This is not surprising if one considers that the small ducts, through which diverticula communicate with the lumen of the bladder, are often occluded, preventing the dye from entering the diverticula. Small stones within the diverticula may also prevent an adequate visualization, even if the gallbladder itself should be demonstrated. These stones, when opaque, may be erroneously interpreted, because they appear to lie outside the visualized organ and do not seem to be related to it.

The roentgenologic characteristics of diverticula are essentially similar to those in the intestinal tract or the urinary bladder. The size of these structures in our case was comparable with diverticula frequently seen in the colon.

It appears rather obvious that diverticulosis of the gallbladder can be demonstrated roentgenologically when the conditions for visualization of mucosal invaginations are favorable, i.e., when the communicating ducts are patent and there are no stones within the diverticula. An inflammatory process of the gallbladder, accompanied by edema and occlusion of the lumina of these "ducts," will in most instances prevent their recognition.

The possibility of diverticulosis should be considered in the presence of small, irregularly distributed opacities in the region of the gallbladder, particularly when the clinical history suggests disease of the biliary tract, and the distribution of these opacities is such that it corresponds with the anatomical contour of the gallbladder.

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DEPARTMENT OF TECHNIQUE

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A MONITOR METER*

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THE following is a description of a simple monitor meter which is permanently built into a roentgen therapy tube stand for the purpose of giving a continuous check on the output, thereby giving the operator as indication of any change in the expected output which may have taken place as the result of a wrong filter, wrong voltage or amperage setting, slippage of the tube within the housing, or for any other reason.

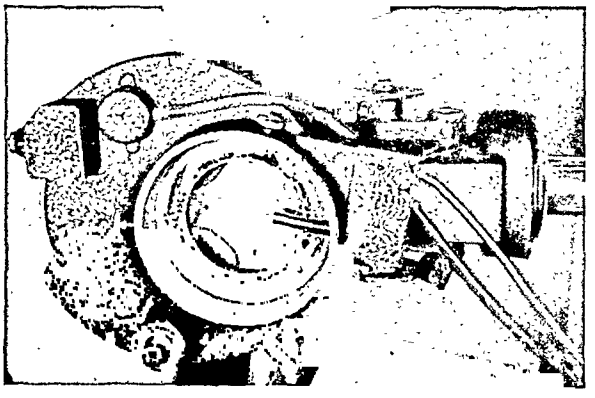


FIG. 1. Ionization chamber mounted in Westinghouse therapy tube stand.

The principal feature of this instrument is that it employs a small ionization chamber which is placed on the edge of the field and therefore does not cast any shadow on that portion of the field normally used for therapy, and causes no increased filtration to the beam, but most important of all, as the space which it occupies is so small, it does not interfere with the machine being operated very close to the patient. There is no interference with any cones.

Figure 1 shows the monitor meter mounted in a Westinghouse therapy machine where the thimble chamber is in the beam, and the metal box housing the amplifier and resistors is fastened at some convenient point reasonably close to the chamber.

The chamber is aluminum and of the thinnest walls that can be conveniently machined. Inside dimensions are 7/8 by 3/8 inch. The collector electrode is a piece of No. 18 copper wire, which is insulated by an amber bushing.

Figure 2 shows the above-mentioned equipment as well as the power-pack and milliampere meter. The milliampere meter may be mounted at any desired point on the control stand and the power-pack inside the control stand. An electrolytic condenser should *not* be used.

Figure 3 shows the wiring diagram, which is in no way unconventional except that the positive side of the system is grounded, raising the amplifier tube to a negative potential, which enables the ionization chamber to be at ground potential, thereby simplifying the mechanical construction.

The cable connecting the amplifier to the power supply is two-wire microphone cable with shield and that connecting the

* Presented in the Scientific Exhibit, Forty-eighth Annual Meeting, American Roentgen Ray Society, Atlantic City, N. J., Sept. 16–19, 1947.

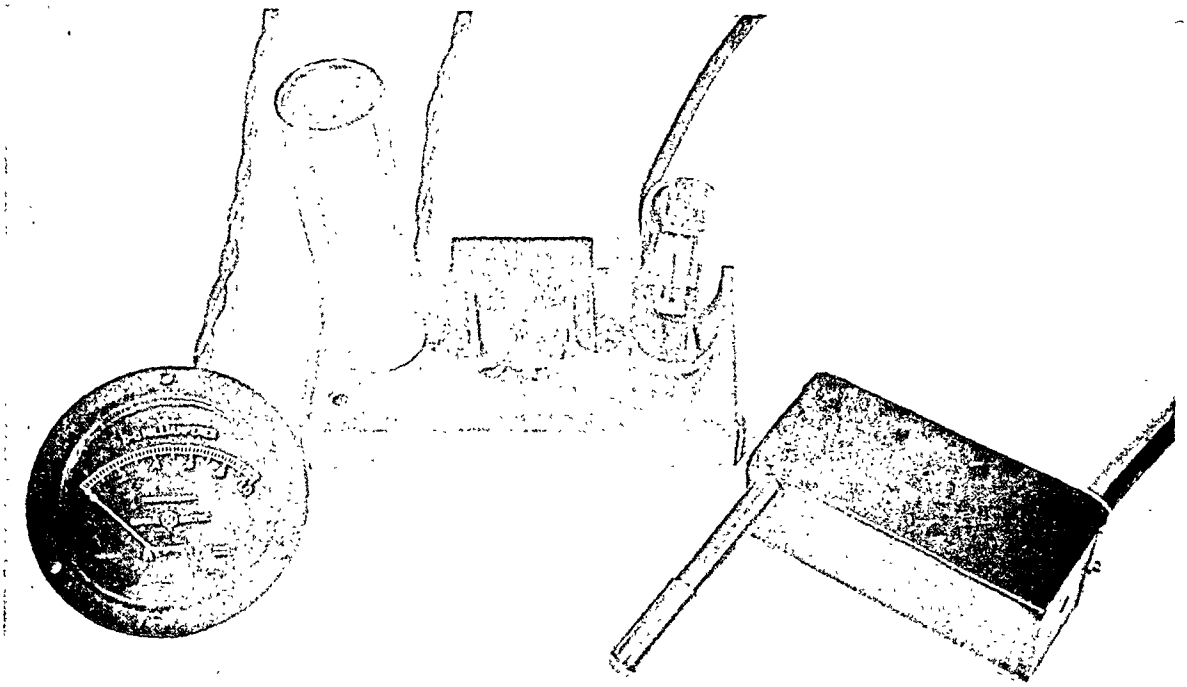


Fig. 2. Component parts of apparatus; amplifier, power-pack, and meter.

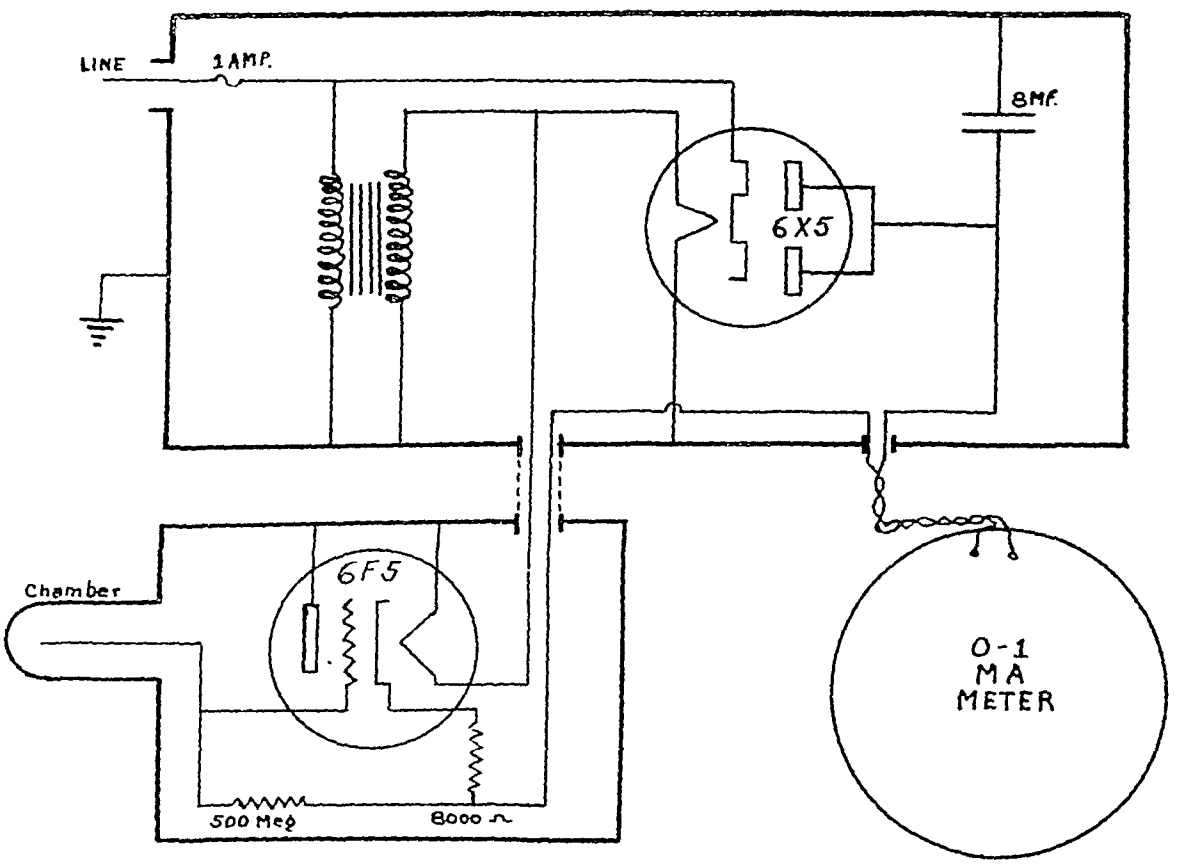


Fig. 3. Wiring diagram.

meter to the power-pack is ordinary twisted lamp cord. These cables may be any desired length.

As fluctuations in line voltage would cause a variance in the reading of this instrument, it is essential that a regulated source of line voltage be used. As most modern therapy machines have a voltage stabilizer in the filament circuit, this instrument may be fed from that source, the required wattage being so low (approximately 9 watts) that no imbalance would result. If no filament stabilizer is available, a small 30 watt line voltage stabilizer, such as built by Raytheon, is now readily available and inexpensive.

To anyone who has not used vacuum tubes of this kind, the following suggestion is made: Obtain several tubes, type 6F5 and, with the meter protected by a resistor of about 1 ohm, leave the instrument in operation for twenty-four hours. After a number of tubes have been aged in this way, the most desirable one will be found.

The sensitivity of the instrument is largely controlled by the cathode resistor which should be a 10 watt wire-wound resistor. It will probably be necessary to try several resistors before such a sensitivity is arrived at to enable full deflection but not to throw the meter off scale.

Normally a well selected tube will give a base current (with no radiation on chamber) of about 0.2 milliampere. No effort is made to buck this out.

The author has used this instrument continuously for approximately ten years and Dr. P. D. Hay of Florence, South Carolina has used one of similar construction for approximately six years, and while it is not intended to be a precision instrument, it has very definitely proved its worth.

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A NEW POSITION FOR CHOLECYSTOGRAPHY

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ROENTGENOLOGISTS are well aware of certain common handicaps to successful cholecystography and that changes in the roentgenographic position often will overcome them. One of these handicaps is the close proximity of the gallbladder to the spinal column in slender persons, which means that with such a patient in the usual roentgenographic position the shadow of the gallbladder is obscured by that of the spinal column. This can be avoided by directing the rays so obliquely that the shadow of the gallbladder will be projected laterally from that of the spinal column (Fig. 1*a* and *b*). There are also cases in which small gallstones are not demonstrable in the routine posteroanterior view, with the patient prone. In many instances, posteroanterior views with the patient standing will disclose the gallstones in layers (Fig. 2*a*, 2*b*, 3*a* and 3*b*). This technique is so often effective that at one time we considered making it routine in all cases in which a normally functioning gallbladder without visible shadows of stones was depicted, but the idea was abandoned because the success of this technique is so often frustrated by the presence of gas in the bowel.

Gas in loops of intestine overlying the gallbladder is perhaps the most common obstacle to satisfactory cholecystography. For many years we have administered beta-hypophamine (pitressin) hypodermically to eliminate gas whenever it has been found to be present in considerable quantities, and resort to this procedure was deemed necessary in 50 to 60 per cent of patients. Before this agent was employed, the making of new roentgenograms was required for about one-fourth of the patients; whereas in most instances the use of this agent precluded any need of a second examination.



FIG. 1. *a*. Posteroanterior view (patient in the prone position), showing shadow of gallbladder behind that of the lumbar portion of the vertebra and sacrum; *b*, same case, with oblique view separating the shadow of the gallbladder from that of the spinal column and sacrum, and depicting gallstones.

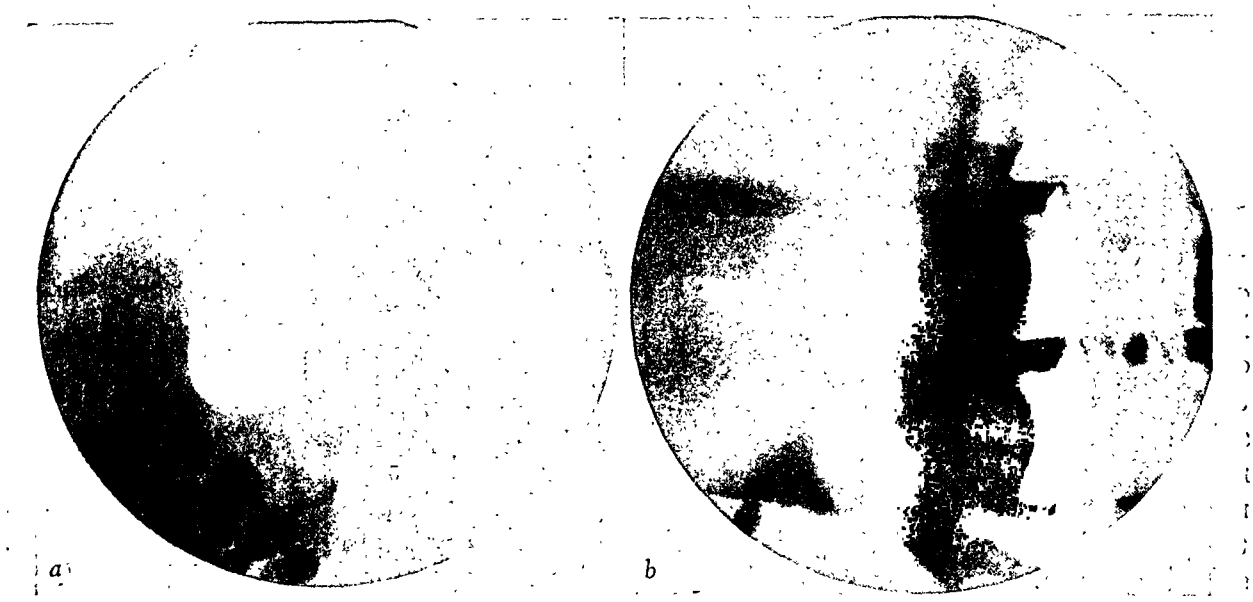


FIG. 2. *a*. A standard posteroanterior view, with the patient in the prone position; *b*, same case, but with the patient standing: note "layering" of gallstones.

Unfortunately, during World War II and shortly thereafter, the exigencies of a wartime economy made pitressin at first difficult to procure and eventually unobtainable, and the problem of overcoming the difficulties caused by intestinal gas again became acute. My chief technician in cholecystography, Mr. Franklin J. Whelan, recalling that changes in the position of the patient and the angle of roentgenography had solved the problem of overlapping shadows of spinal column and gallbladder and of demonstrating layered gallstones, began to try various roentgenographic positions to avoid obscuration of the gallbladder by loops of gas-distended bowel.

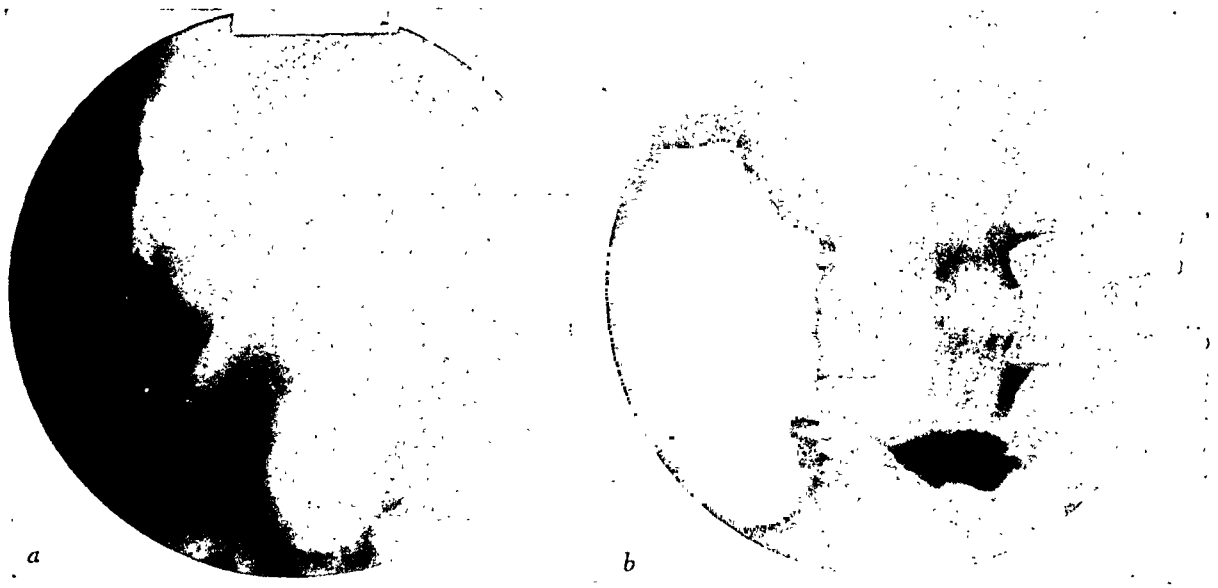


FIG. 3. *a*. Cholecystogram made with the patient in the prone position; *b*, use of the vertical position in the same case, depicting a layer of small gallstones.

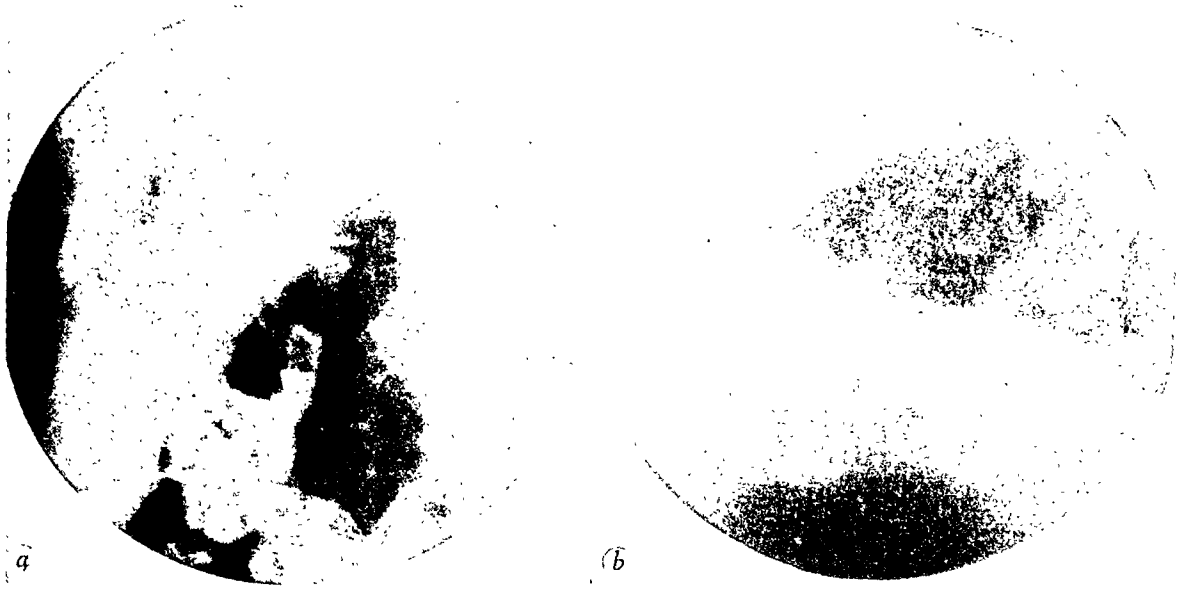


Fig. 4. *a.* Cholecystogram made with the patient in the standard position, showing a normally functioning gallbladder almost obscured by gas in overlying loops of bowel; *b,* posteroanterior view of the gallbladder in the same case, with the patient in the right lateral decubitus position: the gallbladder has fallen away from the gas-distended loops of bowel.

Finally, he decided to employ a posteroanterior view with the patient in right lateral decubitus position. This position permits the gallbladder to gravitate toward the patient's right side and away from loops of bowel in that region. It has all the advantages of the vertical position and is superior to it in that the patient can more easily avoid the movements that blur the shadow of the gallbladder or gallstones, and

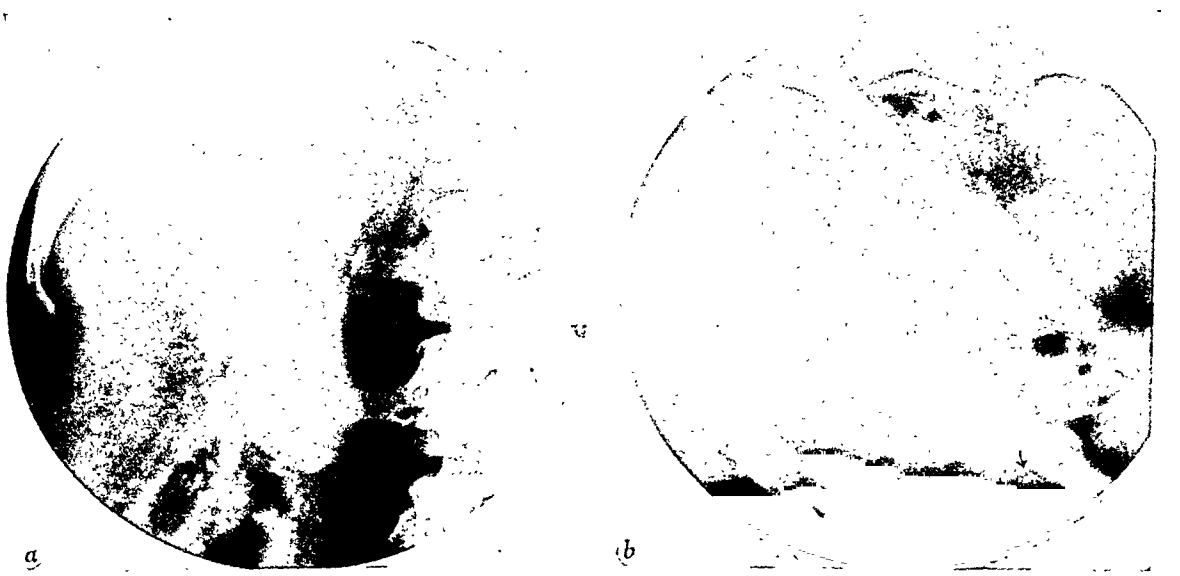


Fig. 5. *a.* Cholecystogram made with the patient in the standard position; it is impossible to identify gallstones; *b,* posteroanterior view in the same case, with the patient in the right lateral decubitus position, showing gallstones lying at the fundus of the gallbladder.

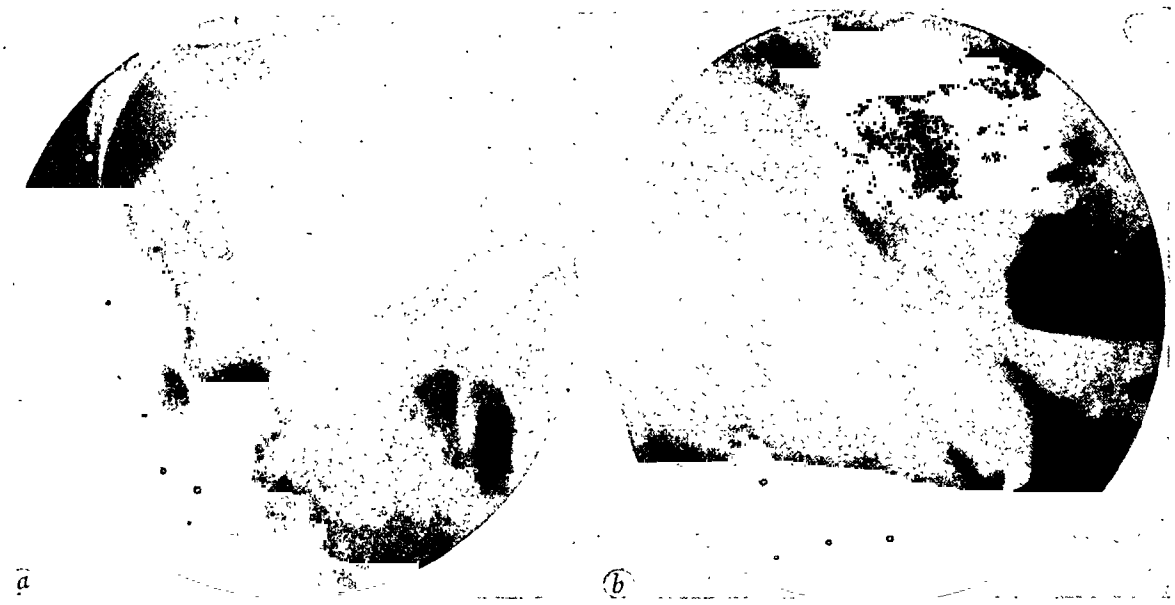


FIG. 6. *a*. Cholecystogram made with the patient in the prone position: the presence of overlying loops of bowel makes it impossible to identify shadows over the fundus of the gallbladder; *b*, posteroanterior view in the same case, with the patient in the right lateral decubitus position: the shadow of the gallbladder and stones is clearly depicted.

it is effective in preventing interference by intestinal gas (Fig. 4*a*, 4*b*, 5*a*, 5*b*, 6*a*, 6*b*, 7*a* and 7*b*). The right lateral decubitus position is also superior for exhibiting the bile ducts, for they will fill with the contrast medium and will be depicted in a greater proportion of cases if this position is used (Fig. 8*a*). Likewise, the position is more

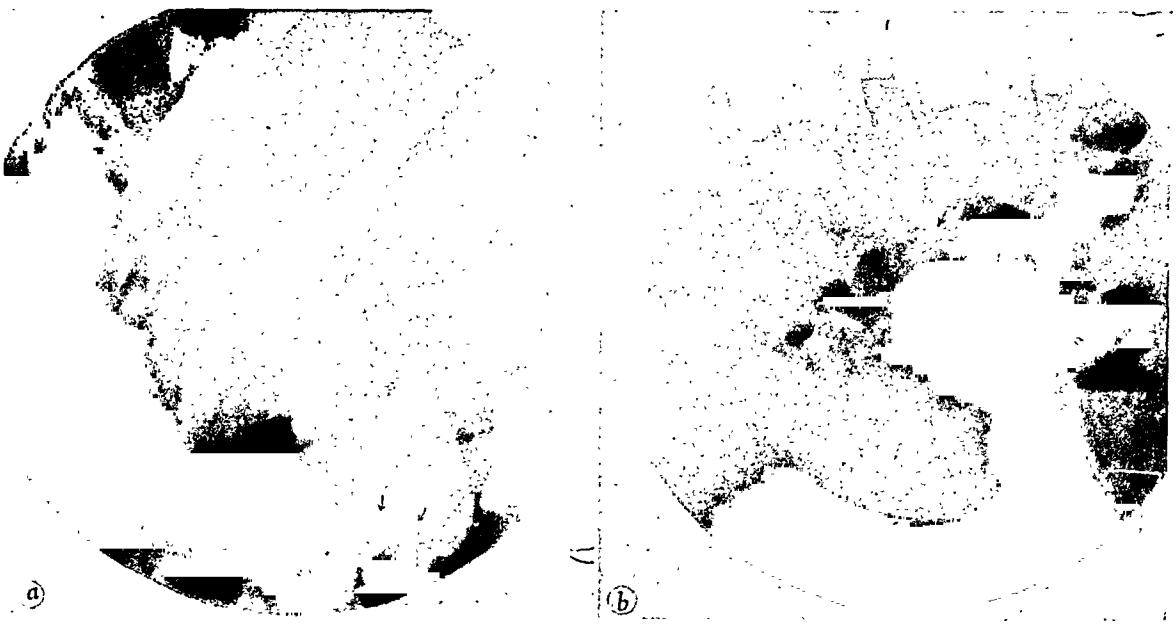


FIG. 7. *a*. Cholecystogram made with the patient in the prone position: note shadows at the fundus of the gallbladder; *b*, posteroanterior view in the same case, with the patient in the right lateral decubitus position: the shadows have not moved with the gallbladder, and therefore are not caused by gallstones.



Fig. 8. *a*. Posteroanterior view of the gallbladder with the patient in the right lateral decubitus position, depicting the bile ducts; *b* (not the same patient as in *a*), posteroanterior view of the gallbladder with the patient in the right lateral decubitus position, during the relaxing phase, and showing "layering" of bile.

facile and more effective in demonstrating the layering of the bile that is of academic interest to many examiners (Fig. 8*b*).

The necessary apparatus was improvised by use of a plain high table, a vertical Potter-Bucky diaphragm in conjunction with a cassette changer, such as is used in roentgenography of the thorax, and a standard tube stand. An 8 by 10 inch loaded cassette is attached to the cassette changer, the patient lies in a true right lateral position with his abdomen against the cassette changer; he is immobilized with a canvas band, and the rays are directed horizontally through the area of the gallbladder. A second cholecystogram is made after the second cassette has been attached 2 inches caudad from the first (Fig. 9).

This technique not only averts interference by intestinal gas, but in many cases also exhibits gallstones that are not depicted by other procedures (Fig. 10*a* and *b*). So efficient has the method been that the administration of pitressin, which is now readily available, is not required in more than 1 per cent of our examinations, and consideration is being given to the use of the right lateral posture in all instances



Fig. 9. Right lateral decubitus position of the patient in front of a vertical Potter-Bucky cassette changer to obtain the desired posteroanterior view.

in which the routine prone position reveals a normally functioning gallbladder without evidence of gallstones. However, I do not



Fig. 10. *a*. Cholecystogram made with the patient in the prone position, showing a normally functioning gallbladder; *b*, posteroanterior view in the same case, with the patient in the right lateral decubitus position, showing a layer of small gallstones.

mean to give the impression that the standard prone position can be discarded, for it is most effective in revealing tumors of the gallbladder, especially adenomas, and should be employed as a routine procedure both before and after administration of the fatty meal.

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Forty-ninth Annual Meeting: Palmer House, Chicago Ill., Sept. 14–17, 1948.

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Thirty-first Annual Meeting: 1949, to be announced.

EDITORIALS

THE RADIOLOGIST CONSIDERS GEIGER COUNTERS

WHILE Geiger counters have been important instruments in the hands of physicists for many years, it is only with the increased availability of radioisotopes that radiologists have become interested in them.

When the radiologist now attempts to read up on this subject and investigate advertisements in the scientific journals, he finds himself rather overwhelmed with the maze of information and technical terms which he has not encountered in clinical work.

The Geiger counter is an extremely sensitive instrument for detecting and possibly measuring many forms of radiant energy and high-speed particles. The essential part of the system consists of an evacuated tube containing an anode and a cathode, the cathode being charged to a high negative potential.

Some tubes require a potential of 800 volts, others as much as 1,500 volts, the voltage for the particular tube being very accurately controlled, because if it is too low, the tube will not operate, and if it is too high, false impulses will be generated.

This tube has in it a small amount of gas at subatmospheric pressure, which, however, is not sufficiently rarefied to permit an electrical surge or brush discharge to take place between its two elements. However, the entrance of a quantum into this tube produces a temporary surge from cathode to anode. In the original instrument this surge was measured on the electrometer but since the advent of vacuum tube amplifiers, this small impulse is magnified electrically to sufficient strength to indicate on a loudspeaker or an impulse counter.

The tube is normally sensitive to roentgen radiation, gamma radiation, and cosmic radiation but if a thin window is placed in the tube to permit beta radiation and alpha particles to enter, it becomes sensitive to them.

When an impulse is started in the tube, it must be stopped by some mechanism in order to make the tube susceptible to the next impulse. Tubes can be built with certain gaseous characteristics making them self-quenching—others that do not have this characteristic are quenched by an external condenser and resistor.

The tube of the externally quenched type is a less expensive tube to build, and has an almost unlimited life, but it has the disadvantage of not being able to take impulses at a rapid rate. A tube of this type, therefore, will be perfectly satisfactory as a detecting instrument, as, for example, for the location of lost radium, and could be used for comparing relatively low intensities of gamma radiation where the radioactive sources could be placed at sufficient distances to bring the intensities well within the handling range of the tube. However, a tube of this kind would not be suitable for the measurement of beta radiation because normally the disintegrations come at too rapid a rate to permit a tube of this kind to handle them, and of course the sources of beta radiation could not be moved away greater distances because the high absorption taking place in air makes the law of inverse squares inapplicable. For the last mentioned purpose a self-quenching tube becomes necessary.

When alpha particles and beta radiation are to be measured by the tube, the window thickness is of great importance, and of course a tube with a thinner window intro-

duces greater manufacturing complications and hence increases the expense of construction. Most manufacturers rate their tubes by the weight in milligrams per square centimeter of window material.

When high intensities of radiation are being delivered to the tube the number of impulses becomes far too rapid to permit an observer to count them or to operate a mechanical counter, and for this reason, all of the more elaborate instruments have incorporated in them what is known as a scaling circuit, by which a radio tube receives one impulse and is rendered inoperable by the next impulse—a number of tubes being connected together in this manner are known by the unscientific, but at least descriptive, term of a "flip-flop" circuit. A circuit of this kind unfortunately does not give a decimal system of numeration, but records on a system of the powers of two; that is, 2, 4, 8, 16, 32, 64. As a rule, the mechanical register is made to operate only on every sixty-fourth count, the intermediate numbers being shown by a neon pilot light properly numbered on the dial.

Recently circuits known as the decade scaler have appeared on the market and if proved satisfactory, will greatly reduce the amount of figuring necessary in any particular operation.

Under most circumstances, the Geiger counter is used for the problem of comparing one intensity of radioactivity with another, in which case a known sample is placed at a convenient distance from the tube and impulses are counted over a reasonable length of time. Inasmuch as the base rate of count of the instrument from cosmic radiation or natural radioactivity is known, that number must be subtracted from the total number of counts received when the known sample is being tested. The unknown is then placed at a similar distance from the tube and the count made for the same length of time, the base rate again subtracted and the two numbers of counts are compared to each other as the values of radioactivity in the two samples. By this means a counter may be said to be calibrated.

Under certain circumstances a counter can be used as an absolute measure of radioactivity inasmuch as the counter gives one impulse for every disintegration which takes place in the radioactive material. However, it is difficult, if not actually impossible, to allow all of the disintegrations to influence the tube unless the radioactive material is actually placed within the tube. As it would obviously be impractical in most cases to place the radioactive sample within the tube, one must be content with allowing a known proportion of all the impulses to influence the tube. From a practical standpoint a small source of radioactive material, such as a drop of radiophosphorus in solution, evaporated on a piece of paper, can be placed directly on the window of the tube so that a hemisphere of radiation will enter the tube (half of all the disintegrations which are taking place). As a millicurie of radioactive material gives thirty-seven million disintegrations per second, the actual radioactivity of a sample can be determined by the impulse counter.

The Geiger tube may also be connected to what is known as a counting rate meter, in which case the individual impulses, instead of being recorded and counted, are fed into a condenser whose potential is determined by a meter. The meter can be calibrated so as to read directly in number of counts per minute. A meter of this type is not as accurate as an actual count of the impulses, but where readings must be taken rapidly and where the counter may be moved around to pick up the strongest point of radiation, as for example over the thyroid gland to determine the greatest concentration of radioiodine, it becomes an extremely handy instrument, which gives precise localizations.

Attention is called to the fact that a Geiger counter can give fair comparisons of radiation only when the qualities of the two types of radiation are the same. There-

fore, some caution should be used when a Geiger counter serves the purpose of a health survey meter because an instrument which is accurately calibrated in fractions of a roentgen for gamma radiation may give entirely false indications when used in the presence of beta radiation or roentgen radiation within the diagnostic range.

In general, counters may be classified as follows:

1. The simple battery-operated instrument indicating the presence of radium or roentgen radiation. This may indicate by means of earphones or a loudspeaker or a flashing lamp. It is used for the recovery of lost radium and it is very valuable for detecting radiation leaks and making protection surveys. In the battery-operated instrument the difficulty arises from the fact that a battery of 900 to 1,500 volts is an expensive, heavy and short-lived piece of equipment. A number of different types of electrical circuits have been developed to give this necessary voltage from a low voltage battery, but in general they are only reliable in the hands of a skilled operator. Where the instrument is to be used by persons totally unfamiliar with it, as would be necessary in civilian protection from atomic warfare, no substitute for the battery has been developed.

2. A scaling circuit meter whose scale may be either of the 64 or of the decade type. It is necessary for making high precision measurements in calculating dosage and studying body fluids or tissue sections.

3. A rate-of-count meter which does not have the accuracy but which is much more simple to use than a scaler circuit. It is used in making comparative measurements for establishing the function of living tissue and for making precise localizations of aberrant or metastatic lesions in the living patient.

In any of the above-mentioned counters, the window thickness of the tube must depend on the type of radiation to be encountered.

Consideration of the above factors should show the radiologist that when he asks what type of counter is the best to purchase, he must qualify this question by a statement as to its intended use.

It is also well to keep in mind that the performance of any complicated piece of equipment is seldom better than the skill of the operator.

ROBERT B. TAFT, M.D.

THE REGISTRY OF RADIOLOGICAL PATHOLOGY

THE Registry of Radiological Pathology is an excellent example of cooperation between the major organizations of the radiologists of North America, and shows what may be accomplished when a worthy cause is presented to them. The American Registry of Pathology has for many years served as a central file for interesting and instructive pathological material from many specialties and has proved its worth to the participating societies. There has been an increasing feeling that radiology should have its place in the Registry. The American College of Radiology, the American Roentgen Ray Society and the Radiological Society of North America have agreed to support a Registry of Radiological Pathology for a trial period. Additional details regarding fellowships at the Registry appear in an announcement in this issue of the JOURNAL in the Department of Correspondence.



THOMAS RAYMOND HEALY
1879–1948

DR. THOMAS RAYMOND HEALY died in the Anna Jaques Hospital in Newburyport, Massachusetts, on February 25, 1948. He had served on the senior staff continuously from 1900 to 1946, when he was retired for age. No other doctor had served the hospital so long.

Dr. Healy was born in Newburyport. He played on the first football team of the Newburyport High School. After graduation from Dartmouth Medical School in 1899, he went into practice with his father, Dr. James J. Healy. His first instructor in roentgenology was the immortal Walter

Dodd. In 1908 he founded the radiological department of the Anna Jaques Hospital, with his own machine. In 1917 he was called to active duty with the Navy, and was made chief radiologist to the Marine Corps; he served at Belleau Wood and Chateau Thierry. The following year he was transferred back to the Navy, and made chief of all X-ray departments of the Navy in France. Later in that year he was assigned to the Chelsea Naval Hospital. In 1920 he was transferred to the Fleet Reserve as medical officer for the first battalion, at the Boston Navy Yard, At the beginning of World War II, Dr. Healy was made commanding officer of the Naval Base Hospital. He was roentgenologist at the Naval Training Station at Newport, Rhode Island, for over a year, and attained the rank of captain.

Dr. Healy was a member of many medical societies. He practiced in Newburyport and in Boston. He served as president of the New England Roentgen Ray Society and the Essex North Medical Society. He was a past commander of Newburyport Post of the American Legion and of the Massachusetts Naval Order and a past vice-commander of the National Naval Order. He was well known as a sportsman. His yacht Ida J. was the champion of her class in New England. He was a member of the Corinthian Yacht Club of Marblehead and of the American Yacht Club. He also owned a racing speedboat. In the bicycle age, he was an active participant, frequently riding a hundred miles. He drove his thirty year old Stutz in 1947 in a revival of the Glidden Tour.

He was a member of the Holy Name Society of the Immaculate Conception Parish, where a solemn requiem high mass was held. He was also a member of the Knights of Columbus, of the Elks, and of the Ancient and Honourable Artillery Society.

Dr. Healy never married. He is survived by a brother, James J. Healy, of Weymouth; by a nephew, Major James K. Healy, of Newburyport, and by a niece, Mrs. Whitefield Kimball of Manchester, Massachusetts.

RAMSAY SPILLMAN

SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

Items for this section solicited promptly after the events to which they refer

MEETINGS OF ROENTGEN SOCIETIES*

UNITED STATES OF AMERICA

AMERICAN ROENTGEN RAY SOCIETY
Secretary, Dr. H. Dabney Kerr, University Hospital, Iowa City, Iowa. Annual meeting: Palmer House, Chicago, Ill., Sept. 14–17, 1948.

AMERICAN RADIUM SOCIETY
Secretary, Dr. H. F. Hare, 605 Commonwealth Ave., Boston, Mass. Annual meeting: 1949, to be announced.

RADIOLOGICAL SOCIETY OF NORTH AMERICA
Secretary, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N. Y. Annual meeting: Hotels Fairmont and Mark Hopkins. San Francisco, Calif., Dec. 5–10, 1948.

AMERICAN COLLEGE OF RADIOLOGY
Secretary, Mac F. Cahal, 20 N. Wacker Drive, Chicago 6. Annual meeting: 1949, to be announced.

SECTION ON RADIOLOGY, AMERICAN MEDICAL ASSOCIATION
Secretary, Dr. U. V. Portmann, Cleveland Clinic, Cleveland, Ohio, Annual Meeting: 1949, to be announced.

ALABAMA RADIOLOGICAL SOCIETY
Secretary, Dr. C. S. Stickley, 515 Bell Bldg., Montgomery, Ala. Next meeting time and place of Alabama State Medical Association.

ARKANSAS RADIOLOGICAL SOCIETY
Secretary, Dr. Fred Hames, 511 National Bldg., Pine Bluff, Ark. Meets every three months and also at time and place of State Medical Association.

BROOKLYN ROENTGEN RAY SOCIETY
Secretary, Dr. A. H. Levy, 1354 Carroll St., Brooklyn 13, N. Y. Meets monthly on fourth Tuesday, October to April.

BUFFALO RADIOLOGICAL SOCIETY
Secretary, Dr. Mario C. Gian, 610 Niagara St., Buffalo, N. Y. Meets second Monday evening each month, October to May inclusive.

CENTRAL NEW YORK ROENTGEN RAY SOCIETY
Secretary, Dr. Dwight V. Needham, 608 E. Genesee St., Syracuse, N. Y. Three meetings a year January, May, November.

CENTRAL OHIO RADIOLOGICAL SOCIETY
Secretary, Dr. Paul D. Meyer, Grant Hospital, Columbus, Ohio. Meets at 6:30 P.M. on second Thursday of October, December, February, April, and June at Seneca Hotel, Columbus, Ohio.

CHICAGO ROENTGEN SOCIETY
Secretary, Dr. T. J. Wachowski, 310 Ellis Ave., Wheaton, Ill. Meets second Thursday of each month October to April inclusive at the Palmer House.

CINCINNATI RADIOLOGICAL SOCIETY
Secretary, Dr. Eugene L. Saenger, 735 Doctors Bldg., Cincinnati 2, Ohio. Meets last Monday of each month, September to May, inclusive.

CLEVELAND RADIOLOGICAL SOCIETY
Secretary, Dr. George L. Sackett, 10515 Carnegie Ave. Cleveland 6, Ohio. Meetings at 6:30 P.M. on fourth Monday of each month from October to April.

DALLAS-FORT WORTH ROENTGEN STUDY CLUB
Secretary, Dr. X. R. Hyde, Medical Arts Bldg., Fort Worth, Texas. Meets in Dallas on odd months and in Fort Worth on even months, on third Monday, 7:30 P.M.

DENVER RADIOLOGICAL CLUB
Secretary, Dr. Mark S. Donovan, 306 Majestic Bldg., Denver 2, Colo. Meets third Friday of each month at Department of Radiology, Colorado School of Medicine.

DETROIT ROENTGEN RAY AND RADIUM SOCIETY
Secretary, Dr. E. R. Witwer, Harper Hospital. Meets monthly on first Thursday from October to May, at Wayne County Medical Society Building.

FLORIDA RADIOLOGICAL SOCIETY
Secretary, Dr. J. A. Beals, St. Luke's Hospital, Jacksonville, Fla. Meets twice yearly, in April preceding annual meeting of Florida Medical Society, and in November.

GEORGIA RADIOLOGICAL SOCIETY
Secretary, Dr. Robert Drane, DeRenne Apartments, Savannah, Ga. Meets in mid-winter and at annual meeting of Medical Association of Georgia in the spring.

HOUSTON X-RAY CLUB
Secretary, Dr. Curtis H. Burge, 3020 San Jacinto St., Houston 4, Texas. Meets fourth Monday each month.

RADIOLOGICAL SOCIETY OF KANSAS CITY
Secretary, Dr. Arthur B. Smith, 800 Argyle Bldg., Kansas City, Mo. Meets third Thursday of each month.

ILLINOIS RADIOLOGICAL SOCIETY
Secretary, Dr. Wm. DeHollander, St. John's Hospital, Springfield, Ill. Meets three times a year.

INDIANA ROENTGEN SOCIETY
Secretary, Dr. J. A. Campbell, Indiana University Hospitals, Indianapolis 7. Meets second Sunday in May.

IOWA X-RAY CLUB
Secretary, Dr. Arthur W. Erskine, 326 Higley Bldg., Cedar Rapids, Iowa. Luncheon and business meeting during annual session of Iowa State Medical Society. Special meetings by announcement.

KANSAS RADIOLOGICAL SOCIETY
Secretary, Dr. Anthony F. Rossitto, Wichita Hospital, Wichita, Kansas. Meets annually with the State Medical Society.

KENTUCKY RADIOLOGICAL SOCIETY
Secretary, Dr. W. C. Martin, 321 W. Broadway, Louisville. Meets annually in Louisville on first Saturday in Apr.

LONG ISLAND RADIOLOGICAL SOCIETY
Secretary, Dr. Marcus Wiener, 1430-48th St., Brooklyn, N. Y. Meets Kings County Med. Soc. Bldg. monthly on fourth Thursday, October to May, 8:45 P.M.

LOS ANGELES RADIOLOGICAL SOCIETY
Secretary, Dr. Moris Horwitz, 441 No. Camden Drive, Beverly Hills, Calif. Meets second Wednesday each month at Los Angeles County Medical Assn. Building.

LOUISIANA RADIOLOGICAL SOCIETY
Secretary, Dr. J. R. Anderson, 1130 Louisiana Ave., Shreveport. Meets annually during Louisiana State Medical Society Meeting.

LOUISVILLE RADIOLOGICAL SOCIETY
Secretary, Dr. E. L. Pirkey, Louisville General Hospital, Louisville 2, Ky. Meets monthly on second Friday at Louisville General Hospital.

MICHIGAN ASSOCIATION OF ROENTGENOLOGISTS
Secretary, Dr. R. D. McDuff, 220 Genesee Bank Bldg., Flint 3, Mich.

MILWAUKEE ROENTGEN RAY SOCIETY
Secretary, Dr. C. A. H. Fortier, 231 W. Wisconsin Ave.,

* Secretaries of societies not here listed are requested to send the necessary information to the Editor.

Milwaukee, Wis. Meets monthly on second Monday at University Club.

Minnesota Radiological Society
Secretary, Dr. Chauncey N. Borman, 802 Medical Arts Bldg., Minneapolis 2, Minn. Two meetings yearly, one at time of Minnesota State Medical Association the other in the fall.

Nebraska Radiological Society
Secretary, Dr. Ralph C. Moore, Nebraska Methodist Hospital, Omaha 3, Nebr. Meets third Wednesday of each month, at 6 P.M. at either Omaha or Lincoln.

New England Roentgen Ray Society
Secretary, Dr. George Levene, Massachusetts Memorial Hospitals, Boston, Mass. Meets monthly on third Friday, Boston Medical Library.

New Hampshire Roentgen Ray Society
Secretary, Dr. A. C. Johnston, Elliott Community Hospital, Keene, N. H. Meets four to six times yearly.

New York Roentgen Society
Secretary, Dr. Ramsay Spillman, 115 East 61st St., New York City. Meets monthly on third Monday, New York Academy of Medicine, at 8:30 P.M.

North Carolina Radiological Society
Secretary, Dr. J. E. Hemphill, 323 Professional Bldg., Charlotte 2, N. C. Meets in May and October.

North Dakota Radiological Society
Secretary, Dr. C. O. Heilman, 807 Broadway, Fargo. Meetings held by announcement.

Northern California Radiological Club
Secretary, Dr. C. E. Grayson, Medico-Dental Bldg., Sacramento 14, Calif. Meets at dinner last Monday, every second month, except June, July and August. Next meeting Sept. 27, 1948.

Ohio State Radiological Society
Secretary, Dr. Carroll C. Dundon, 2065 Adelbert Road, Cleveland 6, Ohio.

Oklahoma State Radiological Society
Secretary, Dr. W. E. Brown, Tulsa, Okla. Three regular meetings annually.

Oregon Radiological Society
Secretary, Dr. William Y. Burton, 242 Medical Arts Bldg., Portland 5, Oregon. Meets monthly 2nd Wednesday, 8:00 P.M., Library of University of Oregon Medical School.

Orleans Parish Radiological Society
Secretary, Dr. Joseph V. Schlosser, Charity Hospital, New Orleans 13, La. Meets first Tuesday of each month.

Pacific Northwest Radiological Society
Secretary, Dr. S. J. Hawley, 1320 Madison St., Seattle 4, Wash. Meets annually in May.

Pacific Roentgen Society
Secretary, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association.

Pennsylvania Radiological Society
Secretary, Dr. J. M. Converse, 416 Pine St., Williamsport.

Philadelphia Roentgen Ray Society
Secretary, Dr. Arthur Finkelstein, Graduate Hospital, 19th and Lombard St. Meets first Thursday each month October to May, at 8:00 P.M., in Thomson Hall, College of Physicians.

Pittsburgh Roentgen Society
Secretary, Dr. R. P. Meader, 4002 Jenkins Arcade Pittsburgh 22, Pa. Meets 6:30 P.M. at Webster Hall Hotel on second Wednesday each month, October to May inclusive.

Queens Roentgen Ray Society
Secretary, Dr. J. E. Goldstein, 88-29 163rd St., Jamaica 3, N. Y. Meets fourth Monday of each month except during the summer.

Radiological Section, Baltimore Medical Society
Secretary, Dr. Harry A. Miller, 2452 Eutaw Place, Baltimore. Meets third Tuesday each month, September to May.

Radiological Section, Connecticut Medical Society
Secretary, Dr. Robert M. Lowman, Grace-New Haven Community Hospital, New Haven 11. Meets bimonthly second Thursday, at place selected by Secretary.

Radiological Section, District of Columbia Medical Society
Secretary, Dr. A. A. J. Den, 1801 K St., N. W., Washington, D. C. Meets Medical Society Auditorium, third Thursday, January, March, May, October at 8:00 P.M.

Radiological Section, Southern Medical Association
Secretary, Dr. Roy G. Giles, Temple, Texas.

Radiological Society of New Jersey
Secretary, Dr. Raphael Pomeranz, 31 Lincoln Park, Newark, N. J. Meets annually at time and place of State Medical Society. Mid-year meetings at place chosen by president.

Rochester Roentgen Ray Society, Rochester, N. Y.
Secretary, Dr. Murray P. George, Strong Memorial Hospital. Meets monthly on third Monday from October to May, inclusive, 8 P.M. at Strong Memorial Hospital.

Rocky Mountain Radiological Society
Secretary, Dr. Maurice D. Frazer, 1037 Stuart Bldg., Lincoln, Nebr. Meets Salt Lake City, Utah, at Hotel Utah, Aug. 12, 13, 14, 1948.

St. Louis Society of Radiologists
Secretary, Dr. Edwin C. Ernst, Beaumont Medical Building, St. Louis, Mo. Meets fourth Wednesday of each month, except June, July, August, and September.

San Diego Roentgen Society
Secretary, Dr. R. F. Niehaus, 1831 Fourth Ave., San Diego, Calif. Meets monthly, first Wednesday at dinner.

Section on Radiology, California Medical Association
Secretary, Dr. D. R. MacColl, 2007 Wilshire Blvd., Los Angeles 5, Calif.

Section on Radiology, Illinois State Medical Society
Secretary, Dr. Edwin L. Rypins, 427 N. Main St., Bloomington, Ill.

Shreveport Radiological Club
Secretary, Dr. R. W. Cooper, Charity Hospital, Shreveport, La. Meets monthly on third Wednesday, at 7:30 P.M., September to May inclusive.

South Carolina X-Ray Society
Secretary, Dr. T. A. Pitts, Baptist Hospital, Columbia, S. C. Meets in Charleston on first Thursday in November, also at the time and place of South Carolina State Medical Association.

Tennessee Radiological Society
Secretary, Dr. J. M. Frère, 707 Walnut St., Chattanooga, Tenn. Meets annually at the time and place of the Tennessee State Medical Association.

Texas Radiological Society
Secretary, Dr. R. P. O'Bannon, 650 Fifth Ave., Fort Worth 4, Texas.

University of Michigan Department of Roentgenology Staff Meeting
Meets each Monday evening from September to June, at 7 P.M. at University Hospital.

University of Wisconsin Radiological Conference
Secretary, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis. Meets first and third Thursdays 4:00 to 5:00 P.M., September to May inclusive. Room 203, Service Memorial Institute, 426 N. Charter St., Madison.

Utah Radiological Conference
Secretary, Dr. Henry H. Lerner, School of Medicine, University of Utah, Salt Lake City 1. Meets 1st and 3rd Thursdays monthly from 7:30 to 10 P.M., Salt Lake County General Hospital, September to June.

Utah State Radiological Society
Secretary, Dr. M. Lowry Allen, Judge Bldg., Salt Lake City 1, Utah. Meets third Wednesday in September, November, January, March and May.

Virginia Radiological Society
Secretary, Dr. P. B. Parsons, Norfolk General Hospital, Norfolk, Va. Meets annually in October.

Washington State Radiological Society
Secretary, Dr. Homer V. Hartzell, 310 Stimson Bldg., Seattle 1, Wash. Meets fourth Monday each month, October through May, College Club, Seattle.

X-Ray Study Club of San Francisco
Secretary, Dr. Ivan J. Miller, 2000 Van Ness Ave. Meets monthly on third Thursday at 7:45 P.M., first six months of year at Lane Hall, Stanford University Hospital, and second six months at Toland Hall, University of California Hospital.

Cuba

Sociedad de Radiología y Fisioterapia de Cuba
President, Dr. J. Manuel Viamonte, Hospital Mercedes, Habana, Cuba. Meets monthly in Habana.

Mexico

Sociedad Mexicana de Radiologia y Fisioterapia
General Secretary, Dr. D. P. Cossio, Marsella No. 11, Mexico, D. F. Meets first Monday of each month.

British Empire

British Institute of Radiology Incorporated with the Roentgen Society
Medical Members' meeting held monthly on third Friday at 2:30 P.M. and Ordinary Meeting at same time on following Saturday, October to May, 32 Welbeck St., London, W.1.

Faculty of Radiologists
Secretary, Dr. M. H. Jupe, 23 Welbeck St., London, W.1 England.

Section of Radiology of the Royal Society of Medicine (Confined to Medical Members)
Meets third Friday each month at 4:45 P.M. at the Royal Society of Medicine, 1 Wimpole St., London.

Canadian Association of Radiologists
Honorary Secretary, Dr. E. M. Crawford, 2100 Marlowe Ave., Montreal 28, Que. Meetings January and June.

Section of Radiology, Canadian Medical Association
Secretary, Dr. C. M. Jones, Inglis St., Ext. Halifax, N. S.

Société Canadienne-Francaise d'Electrologie et de Radiologie Médicales
Secretary, Dr. Origéne Dufresne, 4120 Ontario St., East, Montreal, P. Q.

Australian and New Zealand Association of Radiologists
Honorary Secretary, Dr. Alan R. Colwell, 135 Macquarie St., Sydney, N.S.W.
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New South Wales, Dr. E. W. Frecker, 135 Macquarie St., Sydney.
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Queensland, Dr. J. Adam, 131 Wickham Terrace, Brisbane.
South Australia, Dr. B. C. Smeaton, 178 North Terrace, Adelaide.
Western Australia, Dr. A. M. Nelson, 179-B St. Georges Terrace, Perth.
New Zealand, Dr. E. G. Lynch, 12 Bolton St., Wellington.

South America

Sociedad Argentina de Radiologia
Secretary, Dr. Guido Gotta, Buenos Aires, Argentina. Meetings are held monthly.

Sociedade Brasileira de Radiologia Medica
Secretary, Dr. Nicola Caminha, Av. Mem de Sa, Rio de Janeiro, Brazil. Meets monthly, except during January, February and March.

Sociedade Brasileira de Radioterapia
Secretary, Dr. Andrelino Amaral, Av. Brigadeiro Luiz Antonio, 644, São Paulo, Brazil. Meets monthly on second Tuesday at 9 P.M. in São Paulo at Av. Brigadeiro Luiz Antonio, 644.

Sociedad Peruana de Radiologia
Secretary, Dr. Julio Bedoya Paredes, Apartado, 2306 Lima, Peru. Meetings held monthly except during January, February and March, at the Asociación Médica Peruana "Daniel A. Carrión," Villalta, 218, Lima.

Continental Europe

Société Belge de Radiologie
General Secretary, Dr. S. Masy, 111 Avenue des Alliés, Louvain, Belgium. Meets monthly, second Sunday at Maison des Médecins, Brussels.

Ceskoslovenská společnost pro röntgenologii a radiologii v Praze
Secretary, Dr. Roman Bláha, Praha XII, stát. nemocnice, Czechoslovakia. Meets monthly except during July, August, and September. Annual general meeting.

Polish Society of Radiology
Secretary, Dr. L. Zgliczynski, 59 Nowogrodzka St., Warsaw, Poland. Next meeting May 13 and 14, 1948.

Gdansk Section, Polish Society of Radiology
Secretary, Dr. A. Smigielska, Akademia Lekarska, Gdansk. Meets monthly last Sunday at 10.30, X-Ray Dept., Akademia Gdansk.

Warsaw Section, Polish Society of Radiology
Secretary, Dr. L. Zgliczynski, 59 Nowogrodzka St., Warsaw, Poland. Meets monthly.

Societatea Romana de Radiologie si Electrologie
Secretary, Dr. Oscar Meller, Str. Banual Mărăcine, 30, S. I., Bucuresti, Roumania. Meets second Monday in every month with the exception of July and August.

All-Russian Roentgen Ray Association, Leningrad.
USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.
Secretaries, Drs. S. A. Reinberg and S. G. Simonson. Meets annually.

Leningrad Roentgen Ray Society
Secretaries, Drs. S. G. Simonson and G. A. Gusterin. Meets monthly, first Monday at 8 o'clock, State Institute of Roentgenology and Radiology, Leningrad.

Moscow Roentgen Ray Society
Secretaries, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky. Meets monthly, first Monday, 8 P.M.

Scandinavian Roentgen Societies
The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association.

Sociedad Espanola de Radiologia y Electrologia
Secretary, Dr. J. Martin-Crespo, Fuencarral, 7. Madrid, Spain. Meets monthly in Madrid.

Schweizerische Röntgen-Gesellschaft (Société Suisse de Radiologie)
President, Dr. H. E. Walther, Gloriastr. 14, Zürich, Switzerland.

FELLOWSHIPS OF THE REGISTRY OF RADIOLOGICAL PATHOLOGY

The Registry of Radiological Pathology has been established through the cooperation and support of the American College of Radiology, the American Roentgen Ray Society and the Radiological Society of North America. This Registry is part of the American Registry of Pathology which, in turn, is one of the four divisions of the Army Institute of Pathology and the only division which operates under the auspices of the National Research Council. The Registry is housed in the same building as the Army Medical Library (formerly known as the Surgeon General's Library).

Fellowships in several other specialties are supported at the Institute of Pathology by organizations sponsoring registries; e.g., the American Academy of Ophthalmology, the American Academy of Orthopedic Surgeons, etc. There are over fifteen specialty registries included in the American Registry of Pathology. In the case of the Registry of Radiological Pathology, the American College of Radiology supplies funds to the National Research Council for general expenses. The American Roentgen Ray Society and the Radiological Society of North America each supports two six-month Fellowships annually which carry monthly stipends of $250.00 per Fellow. The four Fellows thus supported receive appointments starting January 1, April 1, July 1 and October 1, respectively, in order that two Fellows may work together and that continuity of effort may be maintained by a three-months' overlapping of appointments. The work of the Fellows is supervised and coordinated by civilian consultants chosen by the Director of the Institute of Pathology. The consultants are currently Dr. L. H. Garland, San Francisco, California, Dr. Fred J. Hodges, Ann Arbor, Michigan, and Dr. Merrill C. Sosman, Boston, Massachusetts.

Applications are now open for the Fellowships. The American Roentgen Ray Society Fellowships begin July 1 and January 1, and the Radiological Society Fellowships on October 1 and April 1.

In order to facilitate the establishment of the Registry, the American Roentgen Ray Society and the Radiological Society of North America have appointed Fellows who are now working at the Registry. The following outline of their activities to date indicates the nature of the Fellowships:

OUTLINE OF FACILITIES AND ACTIVITIES OF FELLOWS AT THE REGISTRY OF RADIOLOGIC PATHOLOGY

I. Schedule for routine daily activities.
 A. Study of the histopathological slide sets prepared by the American Registry of Pathology. One and one-half to two hours is suggested.
 1. There are thirty-six such sets, two of which cover general pathology and the remainder cover specific subjects.
 2. Supervision by a staff pathologist is made available for the Fellow.
 B. Study of roentgenographic teaching aids already prepared.
 C. Attendance at the three weekly conferences of the professional staff of the Institute. At these conferences both typical and unusual cases are presented. The clinical history, physical and roentgenological findings are presented, the gross specimen demonstrated and the histopathological findings demonstrated by projection.
 D. Attendance at radiological conferences at various Washington hospitals. These include Walter Reed Hospital, Garfield Memorial Hospital and Doctors Hospital.
 E. Consultation with members of the Institute Staff on cases having roentgenograms.

II. The preparation of roentgenographic material at the Registry for teaching aids.
 A. This activity includes two phases:
 1. The addition to such atlases as have been prepared by previous Fellows. This would be done

from current cases as they are added to the Registry as well as from material reviewed by the Fellow through his other activities.

2. The preparation of material on a subject of the Fellow's own choosing (the choice to be approved by the Registry Committee). It should be emphasized that this provides an excellent opportunity for the Fellow to investigate a problem in which he may have a personal interest and at the same time fulfill his obligation to the Registry. Facilities for this type of work are excellent.

III. The Fellow is called upon to assist other members of the staff in consultation on radiologic aspects of their problems and investigations. By the same token, the Fellow may avail himself of advice on the pathologic aspects of his studies.

The majority of the cases now on file at the Institute of Pathology do not include roentgenograms of satisfactory quality for adequate correlation of roentgenologic and pathologic findings. This is largely due to the fact that continuous radiological consultation has not previously been available for the assembly of material. One of the chief obligations of the radiological Fellows is to correct this fault as far as possible by cooperating with the Institute Staff. The completeness of the Registry will depend to a large extent on the cooperation of the radiologists of the United States in sending worthwhile, completely documented cases to be included in the file.

The Registry Committees which will act as advisers of the Registry and select candidates for Fellowship are as follows:

American Roentgen Ray Society
Dr. Vincent W. Archer, Chairman
Dr. Lyell C. Kinney
Dr. Leo G. Rigler
Dr. Merrill C. Sosman
Dr. Paul C. Swenson

Radiological Society of North America
Dr. Frederick W. O'Brien, Chairman
Dr. John D. Camp
Dr. Robert S. Stone

Applications for Fellowship may be obtained by writing to the Chairman of either of the above committees. Application should be made to only one committee and will receive due consideration by either or both of the committees. Final approval of all Fellows rests with the Director of the Institute of Pathology.

Details regarding the Registry of Radiological Pathology, its aims and the steps which led to its establishment may be obtained by writing to Mr. Mac F. Cahal, Secretary, American College of Radiology, 20 North Wacker Drive, Chicago, Illinois.

AMERICAN BOARD OF RADIOLOGY

The fall examination of the American Board of Radiology will be held at the Hotel Floridan, Tampa, Florida, November 1–5, inclusive, 1948. The Southern Medical Association is holding its annual meeting in Miami, Florida, October 25–28, 1948, and the annual Cancer Seminar of the Southeastern States will be held in Tampa on November 8, 9 and 10, 1948. This Seminar is sponsored by the American Cancer Society, Florida Division, and the Florida State Board of Health. A large attendance of physicians is expected. It is hoped that as many candidates as possible can attend both the Southern Medical Association meeting in Miami and the Cancer Seminar in Tampa. All those hoping to be examined in Tampa should have their applications on file with the Secretary not later than September 1, 1948.

B. R. KIRKLIN, M.D., Secretary
Mayo Clinic
Rochester, Minnesota

RESEARCH FELLOWSHIPS—AMERICAN COLLEGE OF PHYSICIANS

The American College of Physicians announces that a limited number of Fellowships in Medicine will be available from July 1, 1949–June 30, 1950. These Fellowships are designed to provide an oppor-

tunity for research training either in the basic medical sciences or in the application of these sciences to clinical investigation. They are for the benefit of physicians who are in the early stages of their preparation for a teaching and investigative career in Internal Medicine. Assurance must be provided that the applicant will be acceptable in the laboratory or clinic of his choice and that he will be provided with the facilities necessary for the proper pursuit of his work.

The stipend will be from $2,200 to $3,200.

Application forms will be supplied on request to the American College of Physicians, 4200 Pine Street, Philadelphia 4, Pa., and must be submitted in duplicate not later than November 1, 1948. Announcement of the awards will be made as promptly as is possible.

THE AMERICAN COLLEGE OF PHYSICIANS ANNOUNCES ITS ANNUAL 1949 SESSION

The American College of Physicians will conduct its Thirtieth Annual Session at New York, New York, March 28 through April 1, 1949. Dr. Franklin M. Hanger, Jr., of New York City is the Chairman for local arrangements and the program of Clinics and Panel Discussions. The President of the College, Dr. Walter W. Palmer, Director of the Public Health Research Institute of the City of New York, Inc., and Professor Emeritus, Columbia University College of Physicians and Surgeons, is in charge of the program of Morning Lectures and afternoon General Sessions.

Secretaries of medical societies are especially asked to note these dates and, in arranging meeting dates of their societies, to avoid conflicts with the meeting of the American College of Physicians, for obvious mutual benefits.

TWENTY-FIRST ANNIVERSARY YEAR OF *HAROFE HAIVRI*

The Hebrew Medical Journal

The appearance of Volume I, 1948, of the *Harofe Haivri, The Hebrew Medical Journal*, inaugurates the twenty-first successful year of its publication under the editorship of Moses Einhorn, M.D. The Journal's contents is not confined to technical medical topics but is divided into several sections covering a variety of related subjects of interest to the medical profession.

The founders had faith in the vitality and growth of modern Hebrew and foresaw that a Hebrew medical publication would be of service to the future medical department of the Hebrew University and of great value in the development and advancement of Hebrew medical literature.

The section on Palestine and Health contains an article by A. Klopstock, M.D. which discusses the high incidence of Amoebiasis in Palestine. Included also is the significant study of Mental Health in Palestine by A. H. Merzbach, M.D., and a survey of the Present Urological Conditions in Palestine by W. Boss, M.D. Dr. M. Buchman describes the history of the Hot Springs of Tiberias and presents a full analysis of their therapeutic value.

In the section on Historical Medicine, Dr. M. Gelber reviews the contribution of the Jewish doctors in Poland during the eighteenth century. The section on Personalia contains a biographical sketch of Dr. I. Seth Hirsch, and his contributions to the field of radiology.

The original articles are summarized in English to make them available to those who are unable to read Hebrew.

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ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

SKELETAL SYSTEM

BARNHARD, LEONARD, and STUBBINS, SAM G. Styloidectomy of the radius in the surgical treatment of non-union of the carpal navicular; preliminary report. *J. Bone & Joint Surg.*, Jan., 1948, *30-A*, 98–102.

The surgical removal of the radial styloid is presented in this paper as an aid in the treatment of malunited and ununited fractures of the carpal navicular. The authors believe the removal of the styloid process simplifies the surgical approach and ensures better visualization and immobilization of the fragments of the fracture, as well as less likelihood of secondary degenerative changes. By employing the excised styloid fragment for grafting material, the whole operative procedure can be confined to a single operative field.—*R. S. Bromer.*

RODHOLM, A. K., and PHEMISTER, DALLAS B. Cyst-like lesions of carpal bones, associated with ununited fractures, aseptic necrosis, and traumatic arthritis. *J. Bone & Joint Surg.*, Jan., 1948, *30-A*, 151–158.

The authors state it is a matter of common knowledge that cyst-like areas of bone absorption occur about the hip in degenerative conditions of the joint. Few references to the occurrence of such lesions about the wrist in degenerative conditions of the radiocarpal and carpal joints, are to be found in medical literature, although such lesions are not uncommon.

Three cases are reported. In the first, the roentgenograms of the wrist showed a large cyst-like area of central absorption in the capitate, and a smaller area in the triangular bone. There was no sclerosis of the surrounding shell of bone. The cartilage of the radionavicular articulation was narrowed, and the cortex of the bone was obscured. In the second, on roentgenographic examination, a cyst-like area, without sclerosis about it was shown in the proximal two-thirds of the capitate. The navicular was in two parts, due to old fracture, the proximal portion being narrowed and deformed. There apparently had been aseptic necrosis of the proximal fragment with subsequent collapse and secondary arthritis. In the third patient, an old fracture of the navicular was demonstrated with, however, no evidence of necrosis of the proximal fragment. There was cystic rarefaction of the lunate, with a shell of sclerotic bone about the cyst. A small loose body was noted near the navicular, and there were tiny osteophytes along the articular surface of the radius.

The changes undergone by necrotic bone and cartilage, following interruption of the blood supply to the head of the femur, have been described. The necrotic epiphysis may undergo progressive and complete replacement by living bone. Usually, replacement is incomplete and irregular. Areas of necrotic bone may be absorbed and replaced by fibrous tissue, without subsequent replacement by living bone. These are the cysts seen late in the process. Articular cartilage degenerates and is replaced to a varying degree by fibrocartilage and fibrous tissue.

Pathologically, the cyst-like areas of rarefaction in the carpal bones resemble the cysts of the capital femoral epiphysis, and their pathogenesis may be assumed to be essentially the same. They also bear some resemblance to subcortical cyst-like areas in the femoral head and in the acetabulum at the weight-bearing region in chronic degenerative arthritis. The severity of symptoms in these cases is probably dependent upon the severity of the associated degenerative arthritis. Surgical treatment is beneficial, but, the authors believe, cannot be expected to provide complete relief from symptoms.—*R. S. Bromer.*

FAIRBANK, H. A. THOMAS. Osteogenesis imperfecta and osteogenesis imperfecta cystica. *J. Bone & Joint Surg.*, Feb., 1948, *30-B*, 164–186.

In this paper, a short concise description of osteogenesis imperfecta is given which includes the clinical and histopathological findings and roentgenographic appearance together with case reports and roentgenograms of 12 cases.

Three groups of cases are defined by their roentgenographic appearance:

Type 1. Thick bone type. These are severe prenatal cases, born with limbs which are stunted as in achondroplasia and with numer-

ous fractures, notably in the ribs. The major long bones are short and are usually broad and thick, and show one or more fractures with ample callus. The proximal segments of the limbs, the femora and humeri, are most severely affected, but the tibias may also be enlarged. It may be seen up to three months after birth but is seldom met with later.

Type 2. Sender, fragile bone type. This condition is seen in prenatal cases which survive more than a few months, and in all postnatal cases. The skeleton as a whole is osteoporotic and the long bones are usually slender. The cortex is characteristically thin and of deficient density. The extremities of the bone often appear large, and in older children they may show varying degrees of honeycombing. Occasionally the shafts of some long bones, perhaps after repeated fracture, may be slender and yet surprisingly dense as compared with the ends of the bones. Deformities due to fracture or bending are common. Transverse lines of dense bone, straight or wavy, often mark the ends of the metaphyses. The skull is thin and wormian bones may be present. The vertebral bodies are translucent, shallow spread, and biconcave and the intervertebral discs are biconvex.

Type 3. Osteogenesis imperfecta cystica. This name is suggested for cases with pronounced honeycombing of the bones and is extremely rare. The condition dates from birth, and is definitely progressive. Cystic changes which are more pronounced in the lower than in the upper limbs become increasingly evident with advancing years. Deformity due to fracture and bending of bone is progressive. In the 2 cases reported in the paper the scleras were not blue. The condition differs from multiple diffuse fibrosis of bone in that bone changes occur much earlier, the roentgenographic appearances are not really similar and the histopathological appearances are quite different.—*R. S. Bromer.*

Sherman, Mary S. Osteoid osteoma; review of the literature and report of thirty cases. *J. Bone & Joint Surg.*, October, 1947, *29*, 918–930.

The literature of osteoid osteoma is first reviewed. Included in the series of 30 cases is 1 previously reported by Phemister as a case of "chronic fibrous osteomyelitis" and 2 reported by Compere previously, as *Streptococcus viridans* osteomyelitis. The clinical picture is given in detail with emphasis on the age incidence, and on location of the lesions. In the author's series, over half the patients were between the ages of five and fifteen years. The location of the lesions corresponded well with those given in the literature, with, however, one noteworthy exception, namely, almost 25 per cent were situated in the spine. The chief physical finding was tenderness which usually was definitely localized and which was at times exquisite. Involvement of a lower extremity usually produced a limp and atrophy of the muscles. In the spine, the lesion produced all the signs of acute localized back pain, including muscle spasm, secondary scoliosis and pelvic tilt. If the lesion was present long enough, there was usually palpable thickening of the bone. Lesions in bones with little soft tissue covering were accompanied by swelling, but this area was rarely warm and never red. There were no systemic complaints.

Roentgenographic examination of a mature lesion revealed a characteristic picture. The active nidus was usually a small round or oval area of reduced density. Often one could see within it a small dense shadow which represented ossification of the central portion. About this nidus, a thick, dense shadow of sclerotic regional bone was almost always present. If the lesion was at or in the cortex, the regional hypertrophy, especially along the periosteal surface, was much greater. If the circumference of the shaft was much increased and the bone was sclerotic, the nidus was difficult to demonstrate in the roentgenogram.

The weight of evidence is regarded by the author as against infection as the cause of the lesion. Osteoid osteomata, unlike other benign tumors, are never larger than 1 cm. or so in diameter. Once they have reached a mature state they do not grow, although the hypertrophied regional bone may increase to form a large mass. Furthermore, it is not unusual for benign tumors to be painful, but the pain of osteoid osteomata is out of proportion to their small size. After consideration of all the facts, the author is in agreement with Jaffe that the lesion is not of infectious origin, but is probably best interpreted as a benign tumor.—*R. S. Bromer.*

Lumb, George, and Prosser, T. M. Plasma cell tumors. *J. Bone & Joint Surg.*, Feb., 1948, *30-B*, 124–152.

This review is based on the study of 15 cases. The authors attempt to demonstrate the various manifestations of plasma cell tumors. The

term multiple myelomatosis is used in the paper when a number of bones are involved. Single tumors are described as solitary plasmocytomas, either of the bone marrow or of soft tissue according to their origin. They also correlate their cases with the others already reported in the literature and thus make a comprehensive classification of the disease.

The disease process is divided as follows into three groups:

1. Bone Marrow Tumors
 (a) Multiple at onset.
 (b) Solitary at onset, with subsequent multiple spread.
 (c) Solitary bone marrow tumors.
2. Extramedullary Tumors
 (a) Confined to the nasopharynx.
 (b) Primary in nasopharynx but associated with lymph node involvement.
 (c) Primary in nasopharynx but associated with bone marrow involvement.
 (d) Very rare examples occurring in other tissues, i.e., pleura, testes, skin, etc.
 (e) Confined to the conjunctiva (a somewhat doubtful group probably of granulomatous origin).
3. Generalized Spread (from 1 or 2 above)
 (a) Spread to viscera, liver, spleen, etc.
 (b) Plasma cell leukemia.

In the paper the literature is reviewed, case examples are quoted to show the gradual merging of the different clinical and pathological syndromes into one entity, and a comprehensive analysis of the various manifestations of the disease is made.

The roentgenographic appearance in typical cases of multiple myelomatosis is characterized by multiple circumscribed areas of destruction involving both the cortex and the medulla in which the bone texture has completely disappeared. The lesions occur in any part of the bone and typically they are found in vertebrae, ribs, sternum and skull, eventually affecting any or all bones of the skeleton. The areas appear as clear-cut, punched-out oval or round patches of complete translucency from 1 to 3 cm. in diameter, a characteristic feature being the lack of new bone formation either in the bone itself or in the periosteum. Fractures and, when the lesion is in the vertebrae, areas of collapse are common. Collapse of vertebrae occurs at an early stage and is associated with destruction of the intervertebral disc, in contradistinction to metastatic carcinoma where collapse occurs later and the discs are not involved. Kyphotic deformities are frequent, and differentiation from tuberculosis of the spine may be difficult insofar as this disease is also characterized by destruction of the intervertebral disc. Deficiencies in the skull often simulate those seen in xanthomatosis, but this condition is most frequent in children and young people, and the deficiencies have an irregular outline forming "map-like" appearances. Translucent areas in the skull are also found in osteomalacia and osteitis fibrosa which must be excluded.

Two different types of solitary plasmycytomas of bone marrow are shown in the roentgenogram. Both have essentially identical histological changes. The first type is cystic and resembles an osteoclastoma. The lesion is usually large, of reduced density, and sharply limited; within it are thickened irregular trabeculae. It is usually found in the medullary portion of the pelvis or long bones, frequently expanding the cortex, and pathological fractures may occur.

The second type of lesion is purely destructive and has an appearance very similar to the osteolytic metastasis of a carcinoma, or an osteolytic type of osteogenic sarcoma. It is sharply demarcated, homogeneously rarefied in appearance, and seldom shows expansion. The vertebrae are often involved. The first type is the rarer form.

The finding of plasma cells in the peripheral blood stream is unusual but has been recorded in cases of multiple myelomatosis. Where plasma cells are a constant feature in the peripheral blood stream, in association with other signs of myelomatosis such as Bence-Jones proteinuria and bone marrow invasions, the term plasma cell leukemia is used. The generalized nature of the disease and its course are similar to that seen in other leukemias.

The authors consider that metastasis plays no part in the disease process. They believe the variety of forms of plasma cell tumors which they demonstrate and correlate with the others described in the literature are gradations of an essentially similar process and should not be regarded as separate conditions. The disease should be regarded as of multifocal origin as opposed to any theory of spread by metastasis. No dogmatic statement can be made as to the exact origin of the cells in the plasma cell tumors.—*R. S. Bromer.*

CICCONE, ROY, and RICHMAN, ROBERT M. The mechanism of injury and the distribution of three thousand fractures and dislocations

caused by parachute jumping. *J. Bone & Joint Surg.*, Jan., 1948, *30-A*, 77–97.

This paper describes a series of 3,000 fractures and major soft part tissue injuries resulting from parachute jumping, with particular reference to the traumatic mechanisms involved. The injuries showed a strong predilection for weight-bearing structures; the foot and the ankle, the leg, femur and spine together accounting for 90 per cent of the series. The relative frequency of certain injuries, however, is different from that encountered in civilian orthopedic practice. The series included few fractures of the calcaneus and of the distal end of the radius although both are associated with the trauma of falling. Fractures of the posterior margin of the tibia and multiple metatarsal fractures on the other hand were disproportionately prevalent among parachutists. No injury was specific enough to be called a typical parachute lesion.

Almost all the injuries of parachute jumping can be attributed to four basic mechanisms according to the authors:

(a) Torsion plus landing thrust. This is by far the most common mechanism of injury and is responsible for a chain of related injuries extending from the toes to the hip.

(b) Backward landing. Vertebral compression fractures and head injuries characterize this mechanism of injury.

(c) "Opening shock." This is a mechanism peculiar to parachute jumping. The violent abduction stress causes many ligamentous tears and even fractures of the extremities.

(d) Violent vertical landings. Occasional parachute malfunctions increase the landing impact and cause severe multiple fractures of the legs and spine.

One-half of all parachute fractures of the series involved the ankle mortise. The most prevalent mechanism was external rotation which, together with abduction, accounted for approximately 75 per cent of the fractures at the ankle. The entire lower extremity showed a preponderance of external rotation injuries which would imply a structural weakness of the limb as a whole,—a lack of adaptive resiliency to the stress of external torsion.

The authors regard a classification of fractures based on etiological stresses as much more reasonable than one based on anatomical location. Recognition of the etiological stresses not only relates apparently dissimilar fracture patterns, but also provides a rational approach to treatment.—*R. S. Bromer.*

Fletcher, Gilbert H. Backward displacement of the fifth lumbar vertebra in degenerative disc disease. *J. Bone & Joint Surg.*, Oct., 1947, *29*, 1019–1026.

This paper is based on a study of 600 roentgenograms of the spine, taken on male subjects in the Medical Department of the Veterans Administration Pittsburgh Regional Office. Almost 90 per cent of the patients in the series were less than forty years of age. The universal symptom was backache, most often in the low back; limitation of motion and sciatica were commonly associated complaints. All of the roentgenograms were exposed with the patient in the recumbent position.

Fletcher confirmed the observation of Willis from measurements of skeletons, namely, that there is often a difference in the diameters of the fifth lumbar and first sacral vertebrae. This difference existed in 87 per cent of the cases with backward displacement, and in practically none of the control group. This difference in diameters was found to account for only about one-half of the apparent backward displacement in 85 per cent of the cases of the series, thus disproving the suggestion of Willis that such displacement is only an optical illusion.

Backward displacement is usually associated with degenerative changes in the posterior fibers of the annulus fibrosus and a high incidence of advanced degenerative disc disease Fletcher thus believes that there is a correlation between differences in diameters and disc disease. He found that there is no exaggeration of the lumbosacral angle in backward displacement. The lower lumbar and the upper sacral facets are of frontal or predominantly frontal type, and are in a plane directed downward and backward. The cause of backward displacement lies in the narrowing of the disc. The slipping of the inferior facets of the fifth lumbar vertebra, due to narrowing of the disc, cannot but take place in a downward and backward direction, carrying the entire body of the fifth lumbar backward in its relationship to the first sacral segment. Degenerative disc disease or degenerative changes in the posterior aspect of the annulus fibrosus come first, and posterior displacement is a mechanical consequence. The displacement is greater when the roentgenograms are exposed with the spine in hyperextension; this is due to the fact that hyperextension exaggerates the overriding of the facets and brings out the joint instability.

The differentiation of disc herniation from degenerative disc disease is of great therapeutic

importance because, in disc disease, there is no herniated material to remove for the purpose of alleviating pressure on nerve roots. This explains in great part poor results after surgery. Instead, it would seem logical, in the presence of disc disease and actual backward displacement, to fuse the lumbosacral joint with the lumbosacral junction in hyperflexion, in order to reduce the vertebral slipping as much as possible, and to improve the width of the intervertebral foramina.

When the roentgenologist finds a malalignment of the fifth lumbar with the first sacral vertebra, the lower border of the fifth lumbar and the upper border of the first sacral, as well as the amount of malalignment, should be measured. If the malalignment exceeds the difference in diameters, there is actual backward displacement. Careful scrutiny of the apophyseal joints shows overriding of the facets and eventually impingement upon the pedicles or laminae. A narrowing of the posterior aspect of the lumbosacral disc is commonly found and its significance is controversial; but, when associated with signs of instability, it can be inferred that degenerative changes are taking place.—*R. S. Bromer.*

Lachapèle, A. P. Étude critique des rhumatismes chroniques vertébraux. (A critical study of chronic vertebral rheumatism.) *J. de radiol. et d'électrol.*, 1946, *27*, 285–312.

This excellent paper, actually a twenty-seven-page monograph splendidly illustrated, was presented at the IV Congress of French-speaking Radiologists held in Paris, October, 1946. The essay is divided into four sections:

I. Classical Conception of Chronic Vertebral Rheumatism with consideration of the following types:

1. Spondylitis rhizomelique (Marie-Strümpell)
2. Chronic rheumatic spondylosis with osteophytes (J. Teissier)
3. Traumatic spondylitis (Kümmell-Verneuil)
4. Spondyloarthritis (all types of infectious spondylitis)
5. Chronic rheumatic changes of the spine at present poorly classified
 a. Hereditary—traumatic kyphosis of Bechterew
 b. Fibrous spondylosis—resembling sp. rhisomelique but with long periods of complete arrest of disease during its course (a single proved case—Raymond and Babonneix)
 c. Arthritic changes about apophyseal joints
 d. "Vertical gout"—due to endocrine affects from thyroid and ovary (?)

II. Analysis of the above types of vertebral disease from study of clinical and roentgenological material. Here a meticulous description is presented of the many types listed above together with reproductions of roentgenograms (both clinical and of anatomical material).

III. Rheumatic pains viewed from the standpoint of anatomy and physiology of the spine—Their pathogenesis. Here lumbago and sciatic types of pain are considered from all anatomical physiological (metabolic, endocrine, biochemical), and embryological points of view.

IV. Conclusions—The practical clinico-roentgenological features of ankylosing spondylitis; traumatic infectious and degenerative forms of vertebral disease with osteophyte production; and the physiological approach to the explanation of backache are re-emphasized. The author ends by calling attention to a quotation by A. Léri placed at the head of the essay and which is applicable in explaining the large gaps in our knowledge of this field of pathology—"In pathology, certain terms have a charm which they do not merit. A qualificative poorly chosen is often adopted by the mass of physicians with an eagerness which the originator himself could not have surmised. The error then lies heavily at the feet of a belief based on preconceived convictions of some investigators, thereby limiting their powers of observation."

To the reviewer of this article the quotation seemed particularly appropriate to the subject of arthritis in general and chronic rheumatic lesions of the spine in particular.—*William M. Loehr.*

Martin, Paul H. Slipped epiphysis in the adolescent hip; a reconsideration of open reduction. *J. Bone & Joint Surg.*, Jan., 1948, *30-A*, 9–18.

Martin describes the operation used by him for slipping of the femoral epiphysis which is not a new procedure but a refinement in technique based on preserving the periosteum on the posterior and inferior aspects of the neck of the femur, both from actual tearing and from tension. Open reduction is done without any preliminary trial of manipulation. Most poor results are caused by improper treatment, and are due to avascular necrosis in the epiphysis of the head. Necrosis in the epiphysis is caused by further damage to its blood supply through the ligamentum teres and the periosteum on the posterior and inferior aspects of the neck.

Manipulation, he believes, should be condemned except in acute traumatic cases, and it should be gentle if attempted. If reduction is not easy, closed methods should be abandoned. Patients in the so-called preslipping stage and those with minimal slipping (less than 1 cm.) are best treated by nailing in situ without reduction. When the displacement is more than 1 cm., and is gradual or has existed longer than two weeks, open reduction should be done without preliminary manipulation. In old united cases, if there is a good hip joint, intertrochanteric osteotomy may be beneficial. Later in life, arthroplasty offers much improvement for the old arthritic hips and especially for the cases with ankylosis.—*R. S. Bromer.*

Farkas, Aladár, Wilson, Milton J., and Hayner, J. Clifford. An anatomical study of the mechanics, pathology and healing of fracture of the femoral neck; preliminary report. *J. Bone & Joint Surg.*, Jan., 1948, *30-A*, 53–69.

In search of a better understanding of fracture of the femoral neck, the anatomy and mechanics of the upper portion of the femur were studied by the authors. Dissection and roentgenographic analysis of the upper portion of the shaft and neck revealed the presence of a highly independent laminar, bony system, from 10 to 12 cm. long, which begins from 2 to 4 cm. below the lesser trochanter and ends in a fanlike fashion at the cartilaginous plate of the head. This proved to be the internal weight-bearing system of the proximal portion of the femur. This system, they found, undergoes slow resorption in its distal portion after middle age, but never disappears. On the roentgenogram it can be seen throughout life from its distal to its proximal end. Microscopically, it consists of a great number of laminae and bone cells, and a rich endosteal lining. It resembles the spongy laminae of the iliac bone, hence the speed with which it is capable of new-bone formation

Mechanically, the internal weight-bearing system is a compression system, and during weight-bearing it is found to be almost in the vertical plane. The presence of tensile stresses is doubtful. Preceding adduction fractures, the internal weight-bearing system is resorbed and replaced by cortical bone in its entire distal portion. Its proximal end remains spongy, with laminar character. The separation occurs at the site where the spongy proximal portion begins and the distal cortical portion ends. In abduction fractures, the internal weight-bearing system suffers only trauma, but is otherwise healthy and strong. On this basis, the authors explain the rapid healing of such fractures.

On the basis of the anatomy and pathology of the femoral neck, two types of fracture may be distinguished: (1) compression fractures, comprising the abduction, intermedial, and adduction fractures; and (2) subcapital separations, represented by most fractures of the aged. The prognosis of the compression fractures is good, if the fragments are kept in good apposition and fixation in plaster, in Russell traction, or by nailing.—*R. S. Bromer.*

Golding, F. Campbell. Congenital coxa vara. *J. Bone & Joint Surg.*, Feb., 1948, *30-B*, 161–163.

The author suggested in a previous communication that congenital coxa vara and the short femur of micromelia were variations of the same congenital anomaly. In that paper he reported 11 patients, 1 of whom has been followed over a period of thirteen years. In this paper he adds 2 more cases.

The upper shaft of the congenitally short femur, which appears to be absent, is actually formed in cartilage though imperfectly. The roentgenographic appearances in later life depend upon the extent to which this cartilage is converted to bone. In early months, roentgenograms show only the lower portion of the shaft of the femur and there is no evidence of the upper portion of the shaft, neck or upper femoral epiphysis. When the upper femoral epiphysis appears, it leaves a broad band of cartilage in the region of the epiphyseodiaphyseal junction. The development of separate areas of ossification within this zone of cartilage gives an appearance "fragmentation" which has sometimes been mistaken for osteochondritis, and for the appearance of "triangular fragments," often described in the lower portion and sometimes in the upper part of the femoral neck. These are of no particular importance. Final ossification is delayed, weight-bearing meanwhile causing deformity or even complete solution of continuity. A second area of imperfect and delayed ossification may also be found below the trochanters where the shaft is frequenty thin, sometimes dense, and the differentiation of medulla and cortex is imperfect. The appearances are very variable because the condition develops slowly over many years.—*R. S. Bromer.*

Bronitsky, Jacob. Chondromalacia patellae. *J. Bone & Joint Surg.*, Oct., 1947, *29*, 931–945.

The term "chondromalacia patellae" applies to a circumscribed degeneration of the articular surface of the patella, as evidenced by softening, fibrillation with eventual fissuring and erosion of the cartilage. Trauma has been suggested as an etiologic factor but in many patients no history of trauma can be elicited. Some authors have agreed that, although trauma is the primary cause, a predisposed constitution and the peculiar mechanism of the knee joint also play important roles in the formation of the degenerative changes found in the condition. The present theory is that degeneration of the patellar cartilage can exist with or without trauma. Acute trauma or static deformities can influence the origin and progress of the disease. The question of constitutional disposition and heredity as etiological factors is still unsettled.

The earliest detectable lesions are most frequently found on the medial facet, less frequently in the center and occasionally on the lateral facet of the patella. In severe cases, the entire articular surface may be involved. Roentgenograms are of almost no help in making the diagnosis in the early stages of the disease. The evidence of osteophyte formation will verify the presence of degeneration of the articular cartilage; but in a large number of cases, even osteophytes do not show in the roentgenograms. Indentation of the patellar cartilage, attributed to contusion of the articular surface has been described by Haglund. Other writers, however, have been able to show that this indentation is a frequent finding and has no relationship to trauma or to chondromalacia of the patella.

In a patient in the early years of the third decade, with a history of chronic discomfort in the knee which does not respond to conservative treatment, with also weakness of the joint, tendency to locking, occasional swelling and pain on the mesial side of the joint, the diagnosis of chondromalacia of the patella must be taken into consideration. If patellar crepitation or grating is present, this diagnosis can be made with a greater degree of certainty. In young individuals, a positive diagnosis of the condition can only be made at the time of operation.

In regard to operation the author found that patellaplasty or chondrectomy, combined with some form of covering for the articular surface, gave consistently poor results. The surgery of choice is either the partial chondrectomy or the patellectomy.—*R. S. Bromer.*

Mumford, E. B. Congenital dislocation of the patella. *J. Bone & Joint Surg.*, Oct., 1947, *29*, 1083–1086.

A case of congenital dislocation of the patella in a white woman, aged twenty-five, is reported. A congenital dislocation of the patella is a constant condition in contradistinction to the recurrent type of dislocation which is a changing condition. Roentgenograms of the patient showed, in the right knee, lateral displacement of the patella, the presence of a small loose body beside the lateral femoral condyle and a depression in the condyle corresponding to the size and position of the body. The roentgenographic diagnosis of dislocation of the patella was confirmed by physical examination, as well as at operation, and the case was classified as the congenital type. In the patient's family history similar trouble with the knees existed in four successive generations. Mumford recommends the operation of Conn for this condition which he believes offers a satisfactory prognosis. Congenital dislocation of the patella presents an entirely different operative problem than does the recurrent type of dislocation. As the condition progresses extensive joint changes may occur. The family history of a "knee condition" in four successive generations suggests an element of heredity on the maternal side.—*R. S. Bromer.*

Harris, Herbert W., and Meyers, Solomon G. Salmonella suipestifer infection of the knee joint. *J. Bone & Joint Surg.*, Jan., 1948, *30-A*, 217–219.

Salmonella suipestifer, a paratyphoid organism, also known as *Salmonella choleraesuis*, gives rise to three clinical syndromes: (*a*) acute gastroenteritis (it may be a cause of epidemics of "food poisoning"); (*b*) a typhoid-like fever due to bacteriemia, and (*c*) a pyogenic infection, in which the organism becomes localized in any one of a number of sites. Because of the absence of gastrointestinal symptoms in some infections with this organism, and because the reputation of this organism as an abscess producer is not well known, although firmly established, the authors thought it worth while to report a case of infection of the knee joint with this organism.

The patient was a negro, an army sergeant, admitted to the hospital with fever which

reached 104° F. Three days previously he had had a fracture of the femur. Pain developed in the knee joint which was aspirated and penicillin was injected into the joint. One week later because of continued high fever an arthrotomy was performed, the knee joint was irrigated and penicillin again injected. Six days later his temperature became normal and he was evacuated one month later to the Zone of the Interior in a hip spica. His later course could not be ascertained. *Salmonella choleraesuis* was isolated from the blood culture. No roentgen examination is recorded in the case report.

The patient received both sulfadiazine and penicillin in addition to local therapy to the joint so it is impossible to estimate the efficacy of the individual types of treatment. It is also impossible to estimate the role of the repeated transfusions given him or of the immunity acquired by him, in the subsidence of the disease.—*R. S. Bromer.*

GORDON, EVERETT J., and SHECHTER, NATHAN. Salmonella suipestifer pyarthrosis of the knee joint. *J. Bone & Joint Surg.*, Jan., 1948, *30-A*, 220–224.

A case of infection of the knee joint with *Salmonella suipestifer* is reported. The roentgen examination of the affected knee revealed a degenerative joint lesion, osteochondritis dissecans. This had been aggravated by repeated traumas and the combination of the two may have predisposed the joint to localization of the infection. It, however, did not apparently influence the course of the infection since complete recovery occurred in three months from the time of onset, without extension of the suppurative process into adjoining bones. This might have been expected from the loss of the normal cartilaginous barrier in the region of the osteochondritic effect. The defect showed no roentgenographic change during the course of the infection.

The few cases of typhoid and *Salmonella* infections which have been treated by streptomycin have shown generally unsatisfactory results. Streptomycin was employed in this case, and clinical improvement (fall of temperature and pulse to nearly normal and decreased swelling and pain in the knee) was manifest three days after streptomycin therapy was begun. The joint cultures became negative and remained so, when sufficient streptomycin had been given.

Although the infection resolved completely and the immediate functional result was excellent, the authors believe that the degenerative changes of osteochondritis dissecans, previously present, will result in more joint disturbance at a later date.—*R. S. Bromer.*

COLEMAN, H. M. Recurrent osteochondral fracture of the patella. *J. Bone & Joint Surg.*, Feb., 1948, *30-B*, 153–157.

Two cases of a comparatively rare fracture of the patella are reported. The injury is undoubtedly, in the author's opinion, more frequent than would be expected, and many loose bodies removed from the knee joint have originated from such fractures. The injury is produced by the patella sliding laterally over the lateral femoral condyle and in so doing, scoring the articular surface of both patella and condyle. When the quadriceps contracts, considerable tangential force is applied, which shears off a portion of the articular cartilage of the patella, usually with a thin layer of underlying bone. In both cases reported in this paper, direct pressure had also been applied to replace the dislocated patella.

The defects in the patella could be demonstrated roentgenographically in the 2 cases reported, but lateral, oblique and "sky-line" views were necessary to secure the right projection. A pneumo-arthrogram was tried in one case but it did not make the defect any more clear. The author, however, thinks it would be of value in revealing a defect which involved only the articular cartilage of the patella. He emphasizes that osteochondral fractures of the patella should be recognized early, loose bodies removed, and defects in the articular surfaces smoothed off, or the patella removed if it is extensively involved. He recommends plication of the capsule on the medial side in order to prevent recurrence of the injury and to prevent dislocation of the quadriceps tendon in cases where the patella is removed.—*R. S. Bromer.*

ROSS, DONALD. Disturbance of longitudinal growth associated with prolonged disability of the lower extremity. *J. Bone & Joint Surg.*, Jan., 1948, *30-A*, 103–115.

Impaired function of an extremity during its longitudinal growth may result in a discrepancy of limb length. Paralysis, skeletal infection, trauma and congenital anomalies are among the common causes of impaired function. In such cases, the inequality of limb length is

the result of growth retardation and does not entail premature closure of the epiphyseal cartilage. However, in some patients, marked length discrepancy or alignment deformity develops and in these cases, premature closure of one or more epiphyseal discs can usually be demonstrated.

Growth retardation of the epiphyseal discs precedes permanent arrest. This retardation is due to partial degeneration of the cartilage as the result of atrophy of disuse. Arrested growth occurs later, due to complete degeneration of a portion of the epiphyseal plate and the repair of the defect so formed by a bony ridge. This complete degeneration is probably due to some secondary factor, such as the abnormal stresses present with a faulty gait.

Roentgenographic evidence of growth disturbance is usually present prior to the development of marked inequality of limb length or alignment deformity. It is usually not detected, however, because roentgenograms of the knees of these patients are not made until some factor, such as deformity, calls attention to the knee. By this time there are marked alterations in the epiphyseal cartilages, which represent advanced growth disturbance. The early changes are not observed unless repeated roentgenographic examinations are made from the onset of the disability to the end of the active growth period.

The early alterations of the epiphyseal cartilage, which are evidence of growth disturbance of the knee are thinness of the epiphyseal disc and the presence of a transverse zone of dense bone on its metaphyseal aspect. Growth retardation scars are numerous, and osteoporosis of the regional bone is pronounced. The contour of the epiphyseal cartilage is irregular with one or more peaks projecting into the metaphysis. In some instances, radiolucent defects in the metaphysis are further evidence of deranged endochondral ossification. Such changes may precede actual cessation of growth, but in some instances, recovery of normal longitudinal growth occurs.

If growth arrest does occur, roentgenograms show a bony ridge across the ephiphyseal disc. The transverse zone of bone on the metaphyseal aspect of the disc becomes wider and more dense in the region of this bony bridge, and long trabeculae converge toward its site from both the epiphysis and metaphysis.

Certain sites are more favorable for epiphyseal bridging. In the distal end of the femur, the point of arrest is commonly posterior to the central portion of the disc. The remaining disc may continue to grow, causing posterior rotation of the condyles. In the proximal end of the tibia, the arrest is often in the posterior medial quadrant, in which case continued growth of the remaining cartilage results in tibia vara. Not infrequently, the tibial tubercle unites prematurely with its metaphysis, and tibia recurvata develops. In either case proximal displacement of the fibula in relation to the tibia occurs.

Prevention of growth deformity in chronic diseases of the lower extremity is not always possible. However, Ross states, measures that shorten the duration of disability from hip disease, such as operative fusion, avoidance of prolonged immobilization, and careful supervision of the patient who resumes weight-bearing on a limb which has undergone marked osteoporosis, may minimize the chance of growth arrest. If arrest does occur, early recognition may make it possible to avoid deformity or marked discrepancy in limb length by the employment of an epiphyseal arrest operation.—*R. S. Bromer.*

NISSEN, K. I. Plantar digital neuritis. *J. Bone & Joint Surg.*, Feb., 1948, *30-B*, 84–94.

Morton (1867) described with remarkable clarity the symptoms of the severe type of metatarsalagia which now bears his name: neuralgic pain felt in the sole about the fourth metatarsal joint, radiation of pain to the fourth and sometimes the third toe, onset of pain with walking and standing, and relief of pain by resting with the shoe discarded. Nissen reports a series of cases of the condition in which 27 selected patients had thirty-five operations on the sole of the foot. At operation, degeneration of the plantar digital artery to the cleft between the third and fourth toes was found to precede the fibrous thickening of the nerve described by Betts in 1940. Similar changes rarely occurred in neighboring clefts. Roentgenographic examinations showed no change except in one patient. In this case, the roentgenogram showed separation of the third and fourth metatarsals and toes. A connective tissue mass around the thickened nerve was roughly spherical and almost an inch in diameter and cast a soft tissue shadow in the web space.

Local resection of the digital nerve almost always gave complete relief from pain, and the plantar scar gave rise to no trouble. Histologic findings showed that the nerve lesion was

ischemic in nature. Nissen believes that acute pain arising as a new event in cases of "anterior flat foot" may prove to be due to this condition. He regards the condition as a distinct pathological and clinical entity which can best be described as plantar digital neuritis.—*R. S. Bromer.*

ROENTGEN AND RADIUM THERAPY

Cottentot, Paul, and Bourdon, Rene. La roentgenthérapie à bas voltage et à faible distance (radiothérapie de contact) en dermatologie. (Roentgen therapy at low voltage and short distance (contact therapy) in dermatology.) *J. de radiol. et d'électrol.*, 1946, *27*, 319–332.

This paper comprises a large series of cases treated by contact therapy in the roentgen therapy department of the dermatological center of France—Hôpital St. Louis. The report covers the treatment of 473 patients in this hospital from December, 1942, to January, 1945. Results with different types of lesions are tabulated and discussed. Epitheliomas of the skin were treated (130 cases) at 2 cm. distance (tube in contact with lesion), field not exceeding 30 by 30 mm. In 93 of the epithelioma cases a single massive dose was given with 45 kv. peak (Philips type tube), 0.2 mm. Al, and 2 cm. distance. Total dosage was 10,000 r (approximately) in 81 cases, and in 12 instances the total was from 3,000 to 6,000 r. The follow-up showed 90 per cent cured one to three years after treatment. Two epithelioma cases were treated by fractionation (1 case two seances of 5,000 r and 1 case with 5 seances of 2,000 r). Concerning radionecrosis, 3 cases developed necrosis six to twenty-six months after contact therapy and in each instance developed in cases which had been treated by divers means *before* contact therapy (electron coagulation, roentgen therapy, cauterization with acid). The remaining 343 cases included plantar and palmar warts, angiomas, keloids, nevo-carcinomas (2 successes and 2 failures), keratoses, other dermatoses, and a few lesions (11) on tongue, palate, or buccal mucosa.

The authors emphasize the fact that contact therapy in treatment of skin malignancies is very limited since it can only be used for very small lesions (not exceeding 4 $cm.^2$ area and 1 cm. depth of lesion) and these are lesions which are quite easily treated by more commonly used techniques. One of the purposes of this report is to emphasize the great utility of this method in busy large hospital services where many patients must be handled rapidly and where it would be a great step if, in addition to benign lesions, certain malignant ones could be treated in from only one to several minutes.

The paper discusses the physical factors and physical problems (including the protection of the operator) involved in this type of therapy as well as the difficulty in accurately measuring the roentgens delivered to a lesion being treated with an apparatus of such high output and for such short seances; and in the conclusions formulated by the authors five major objections to this method are given fair consideration.

This is an excellent review of an extensive experience with contact roentgen therapy presented in an unbiased manner. There is a most complete bibliography appended covering this entire subject up to 1946 comprising 219 references including, of course, the American work of Pendergrass (1937 and 1939), Goin (1940), Widmann (1941), Gershon-Cohen (1941), Hodges (1941), and Quimby (1943).—*William M. Loehr.*

Watson, E. M., Herger, C. C., and Sauer, H. R. Irradiation reactions in the bladder; their occurrence and chemical course following the use of x-ray and radium in the treatment of female pelvic disease. *J. Urol.*, June, 1947, *57*, 1038–1053.

Late irradiation bladder reactions are comparatively rare and may be mistaken for carcinoma by those not familiar with the condition. The authors present a study of 164 cases of irradiation reactions in the bladders of 5,990 patients treated for uterine disease; 2,967 of these patients had cancer of the cervix, 898 cancer of the fundus, and 2,125 patients uterine fibromyoma.

Acute irradiation reactions occur during or shortly after therapy and resemble the changes occurring in the skin. In mild cases the patients have symptoms of a mild cystitis and cystoscopic examination reveals mucosal hyperemia. The more severe cases have symptoms of a more severe cystitis and cystoscopic examination reveals a diffusely red-velvet-like mucosa in which individual vessels can no longer be distinguished. In the most severe acute cases, bladder irritability may be so extreme as to result in incontinence. Cystoscopically such bladders will show partial epithelial desquamation with or without superficial erosions.

Treatment of acute irradiation reactions in the bladder consists of discontinuation of the radiation therapy, sedation, bed rest, and mild antiseptics. Recovery should occur in a few weeks, but if an excessive amount of irradiation has been delivered the reaction may become chronic. Delayed reactions with external irradiation are usually due to prior radium applications. The symptoms of late reactions are manifold. They are usually sudden in onset. Painless hematuria and dysuria are common complaints.

The chronic reactions are also divided into three groups. Grade I reactions show circumscribed areas of telangiectasis with elevated tortuous vessels. Rupture of the latter causes painless hematuria. Superficial erosions are not unusual. Grade II late reactions reveal, cystoscopically, fairly deep ulcerations, bullous edema and telangiectasis.

The greatest diagnostic and therapeutic problems are involved with the Grade III lesions. Complications overshadow the classical triad of signs: ulceration, edema, and telangiectasis. The cystoscopic picture may readily be confused with carcinoma. Histopathologically the appearance is also deceiving. Secondary infection and extensive necrosis are common Dysuria, frequency and hematuria are almost constantly present. Eventually most ulcers will heal. When healing fails to take place fistulae may develop. Eventually the upper urinary tract becomes involved from ureteral obstruction secondary to pelvic fibrosis, from ureteral occlusion due to bladder scars, or as the result of ascending infection.

Late radium reactions are due to an endarteritis, ischemia and necrosis. Histopathologically fibrosis, round cell infiltration and epithelial cell inclusions are noted. Important points in the diagnosis of late radium reactions include history of previous radium irradiation, localization of the lesion to the lower posterior bladder wall, the cystoscopic appearance, the histological appearance, and the presence of telangiectasis and fibrosis of the skin and vaginal mucosa.

Grade I lesions only require treatment if severe or persistent bleeding is present, when coagulation, cautiously applied, should be sufficient. In Grade II reactions treatment is directed toward control of secondary infection. In Grade III reactions treatment is that of existing complications. Prognosis is usually good although recovery may be delayed.

The causes of late radium reactions are excessive irradiation, individual sensitivity to irradiation, anatomical variation in the thickness of the cervix, uterus and bladder, and faulty technique in the administration of the radium. Excessive irradiation with radium appears to be the most important single cause of late radium reactions in the bladder. This may be due to an excessive dose delivered in a short time or retreatment of an area previously treated to tolerance. The authors found that dosages of less than 4,000 mg-hr. were responsible for 50 per cent of the total number of irradiation reactions and for more than 50 per cent of the Grade III reactions.

The majority of reactions occurred between the first and fourth years following radium irradiation. Forty per cent of 10 patients who received more than 6,000 mg-hr. developed reactions within one year as compared to 11.6 per cent of 112 patients who recieved less than this amount. No patient who received more than 6,000 mg-hr. developed reactions after more than four years, but 10 per cent of the 112 cases receiving less than this amount developed reactions after from five to thirteen years.

In the matter of individual sensitivity, diabetics and patients with chronic localized infections are more prone to develop reactions. Individual tolerance remains an unknown factor. The effect of variations in the thickness of the cervix, uterus and bladder on irradiation reactions is obvious. In spite of all precautions reactions will occur in some cases.

The actual incidence of late radium reactions in the bladder cannot be determined since patients with too short an interval of time since treatment may develop reactions at a later date. Many patients die of their disease before reactions can occur. Many patients with bladder lesions are never discovered.

The number of reactions has not changed appreciably with changing methods of radium application.

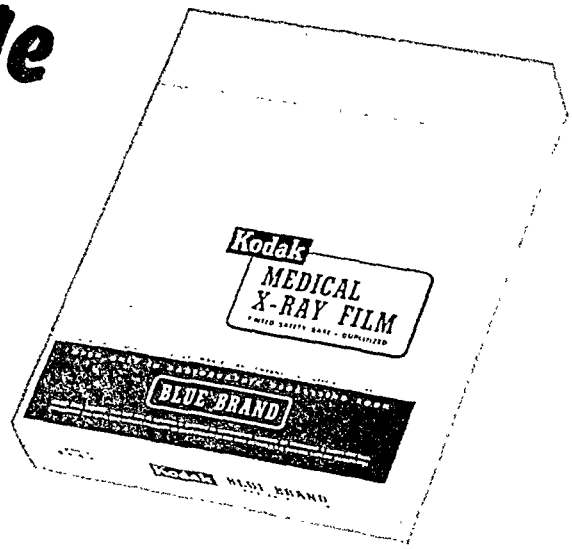
The prognosis of these late radium reactions is almost invariably good; 78.7 per cent of the authors' series healed. Grade I lesions had an average healing time of 4.3 months; Grade II lesions had an average healing time of 5.9 months; and Grade III lesions an average healing time of 18 months.—*Rolfe M. Harvey.*



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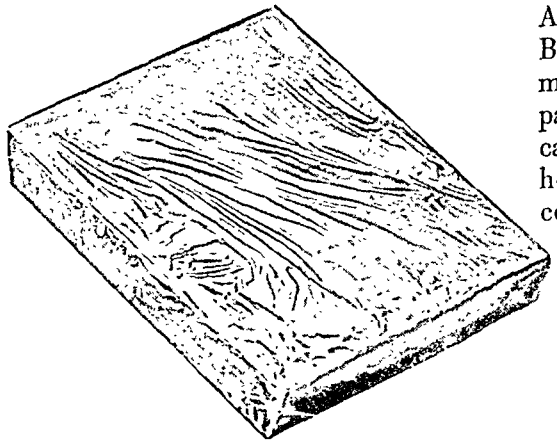
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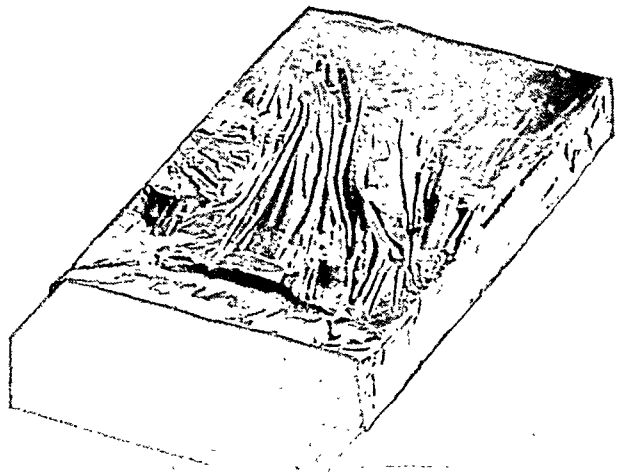
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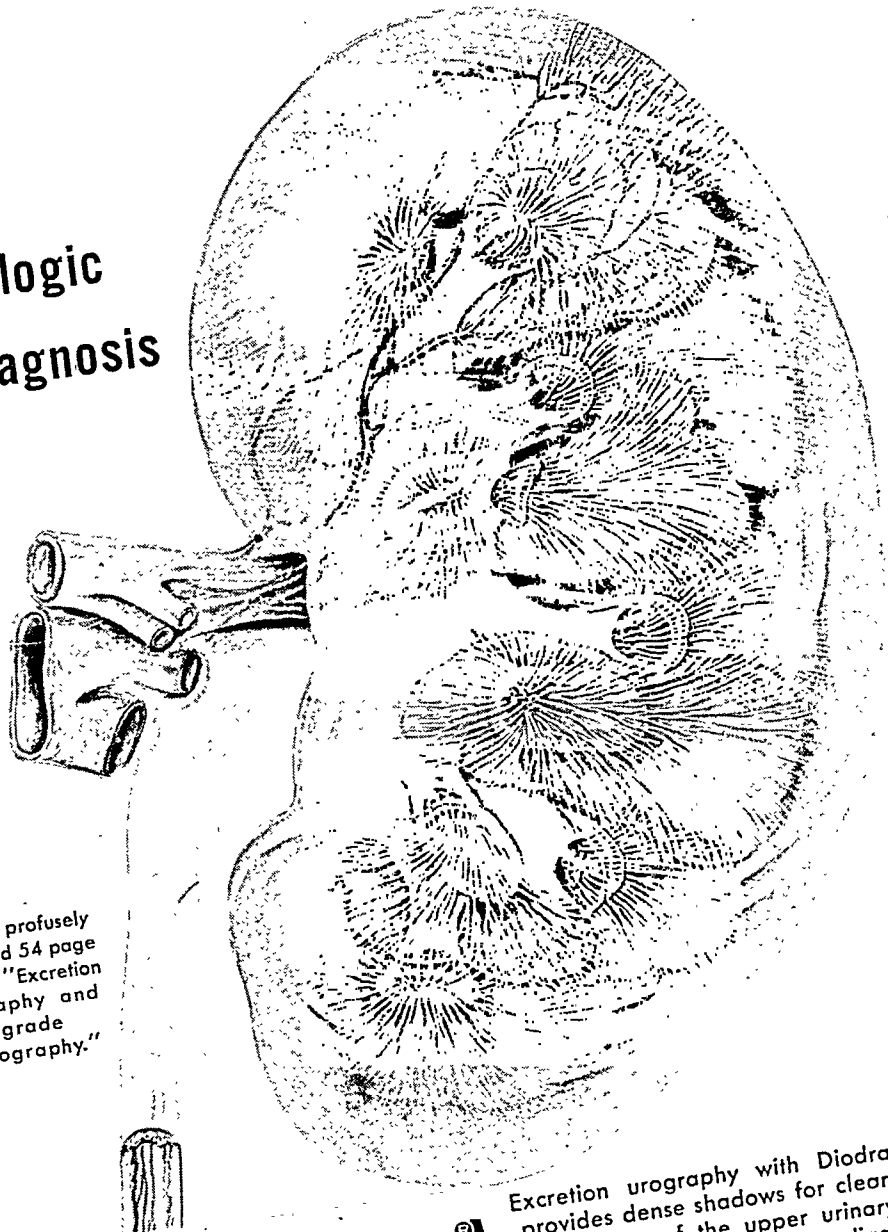
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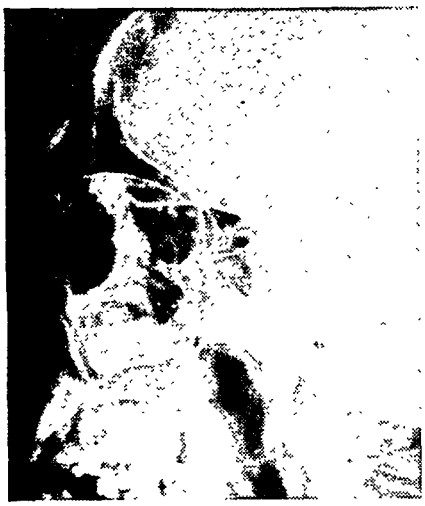
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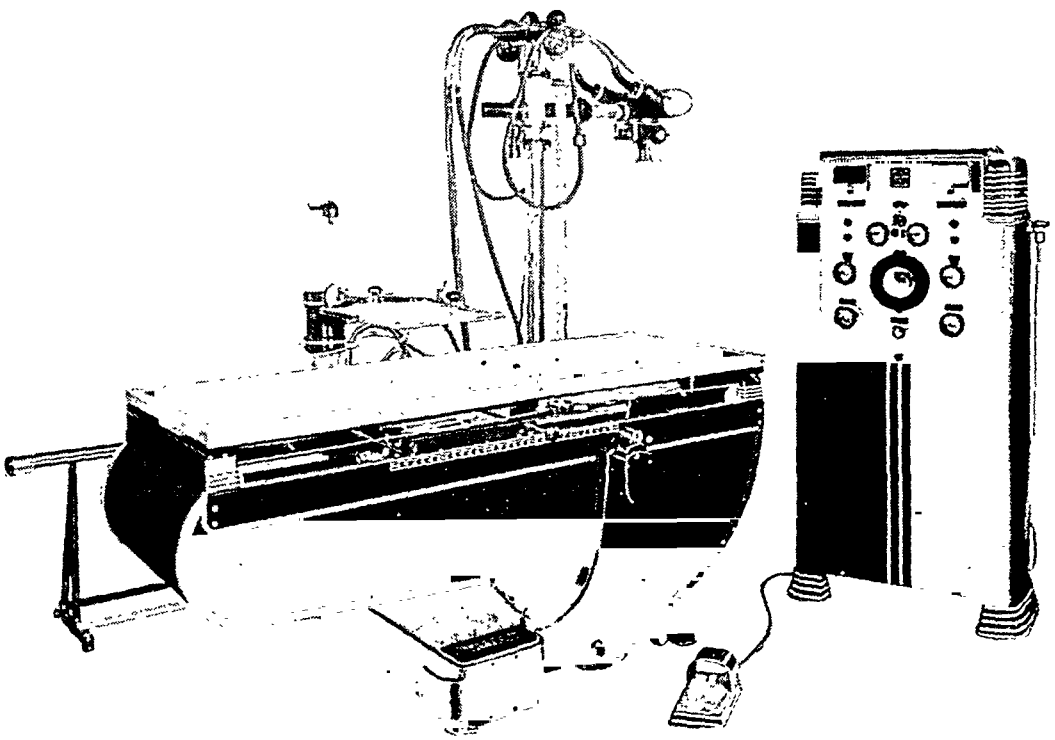


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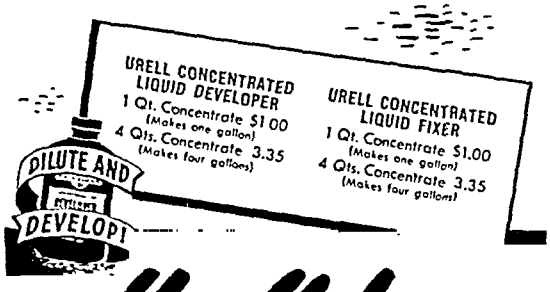
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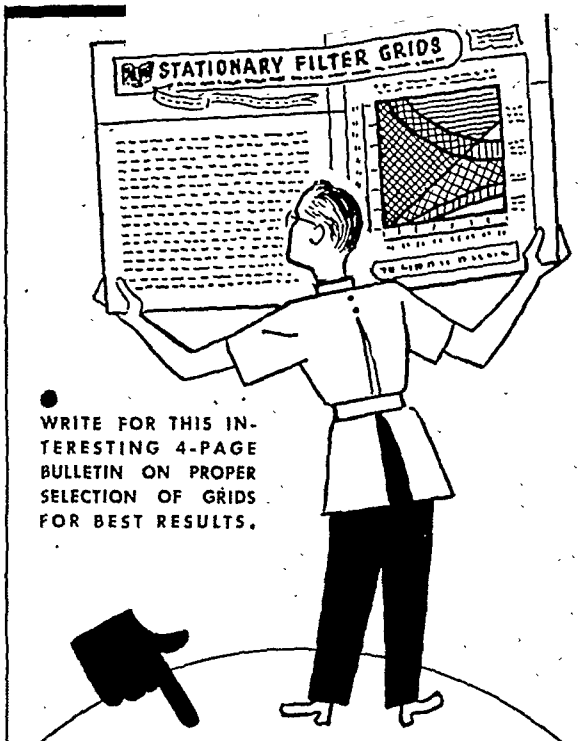
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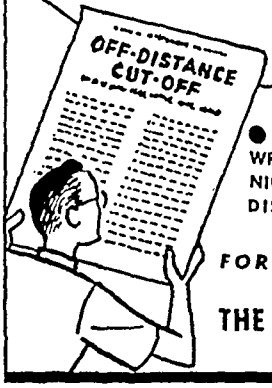


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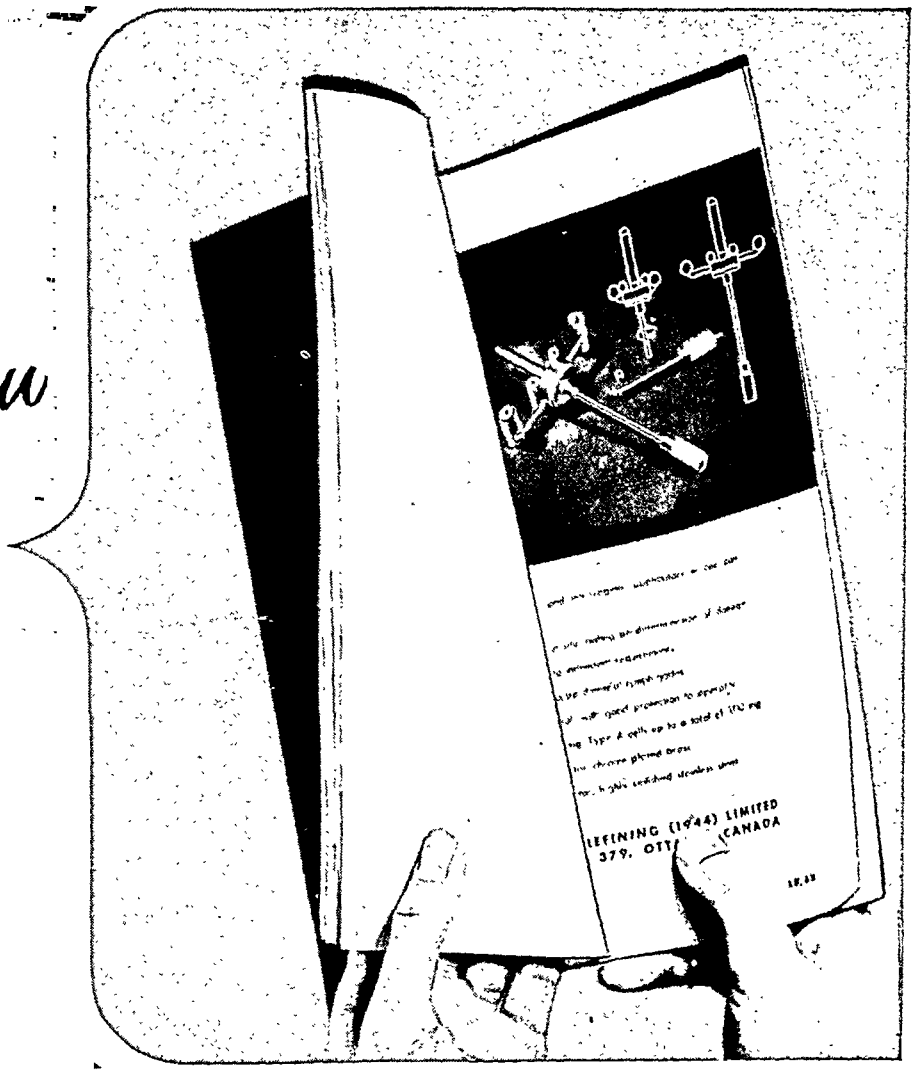
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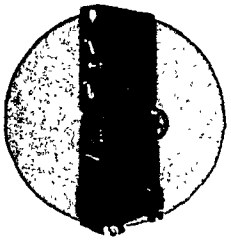
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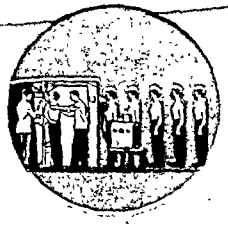
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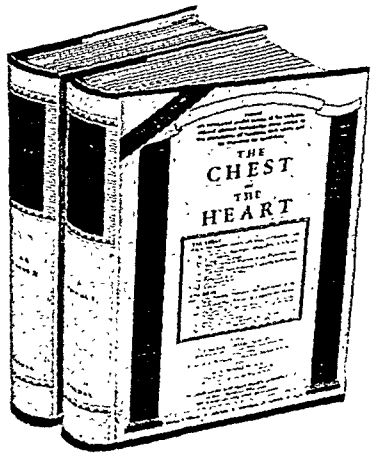
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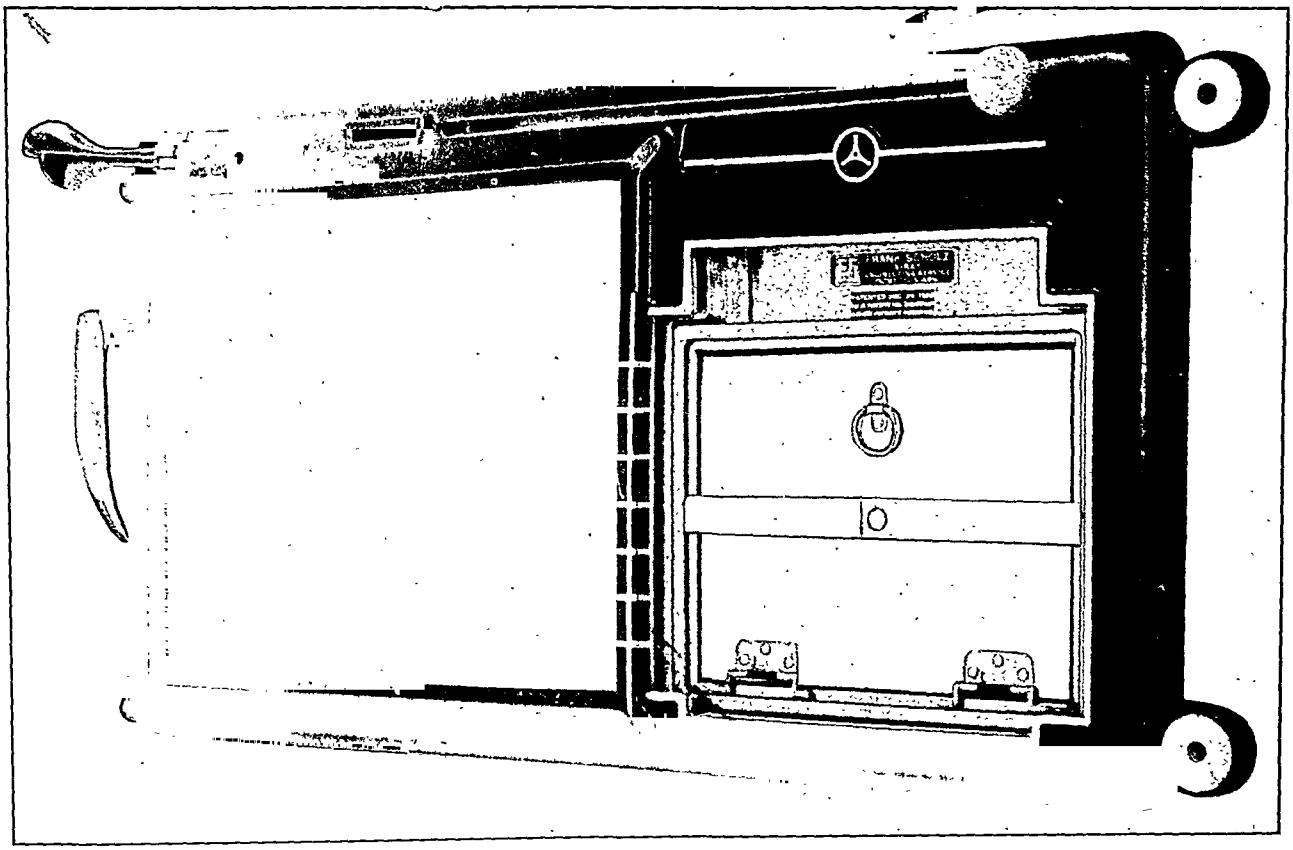
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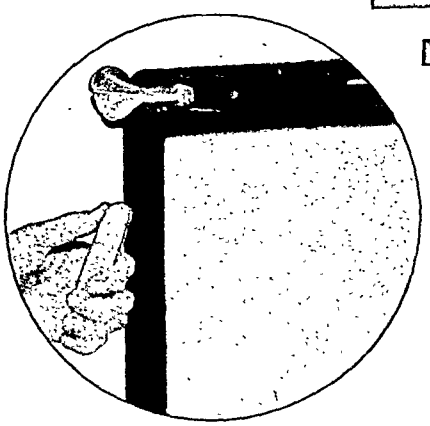
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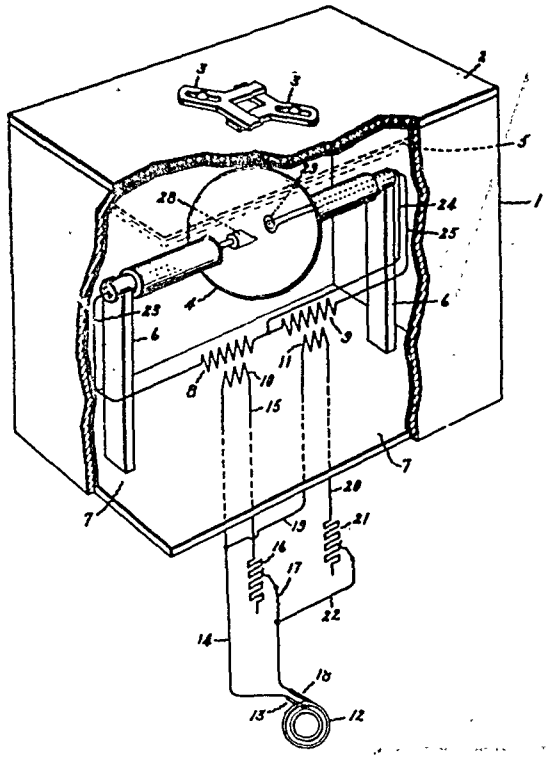
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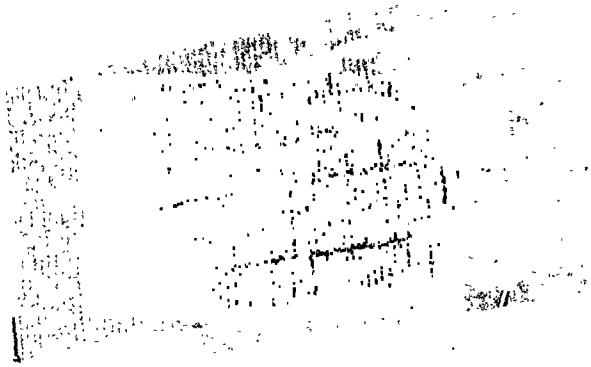
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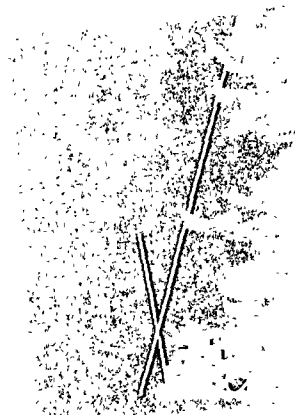
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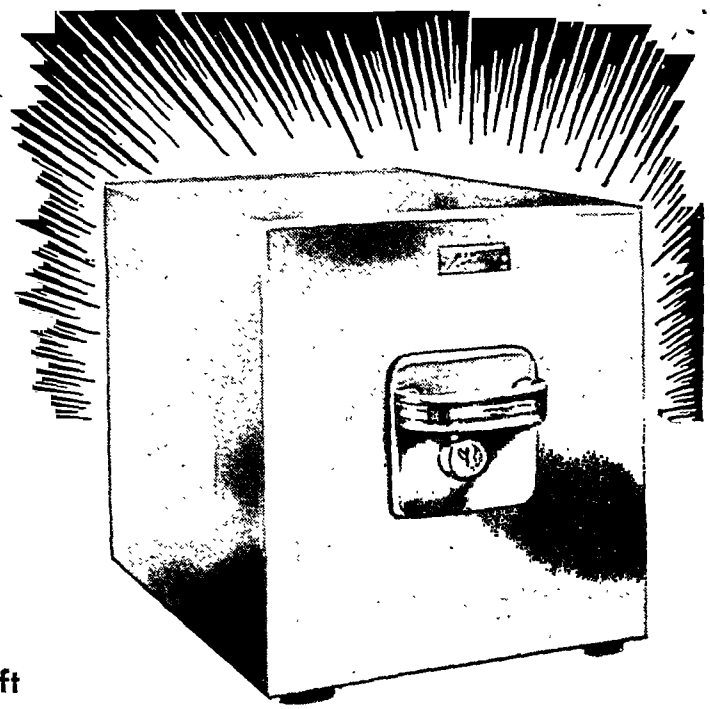
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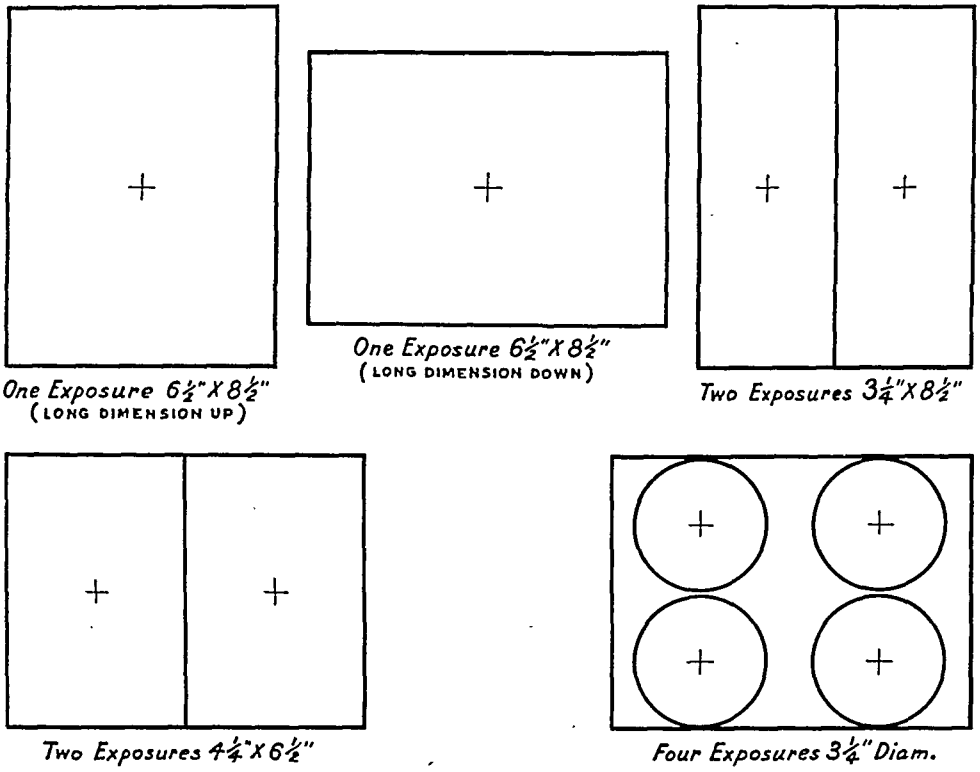
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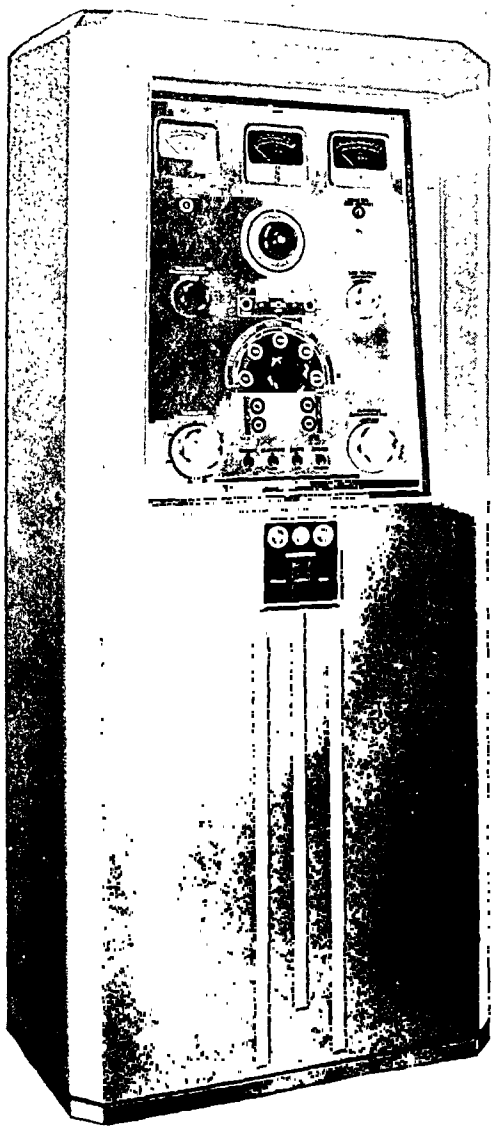
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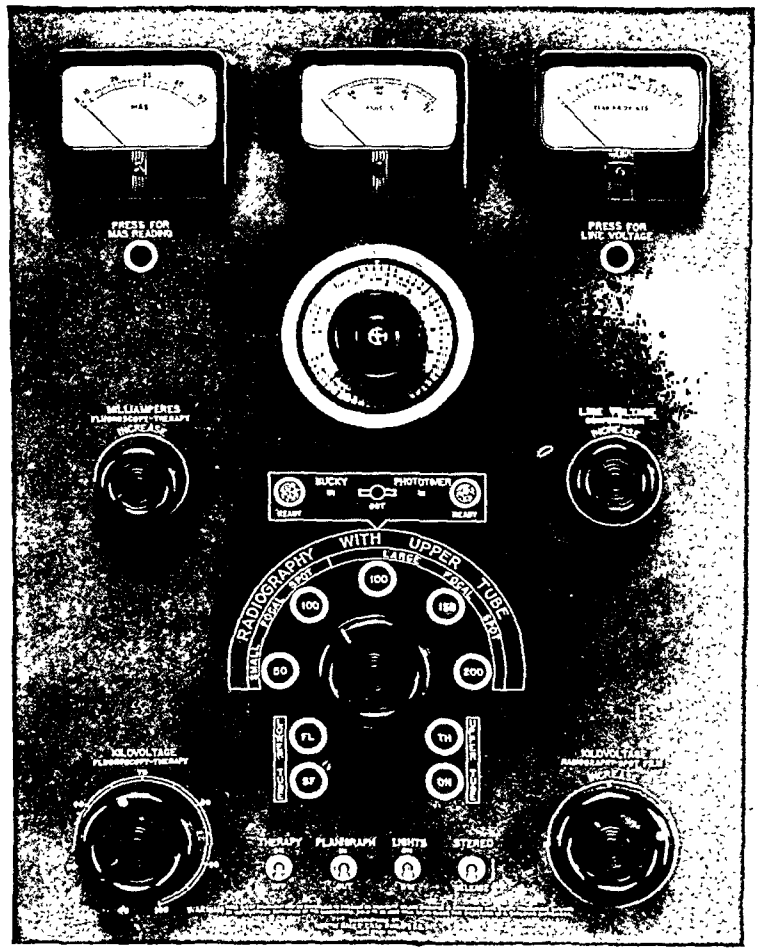
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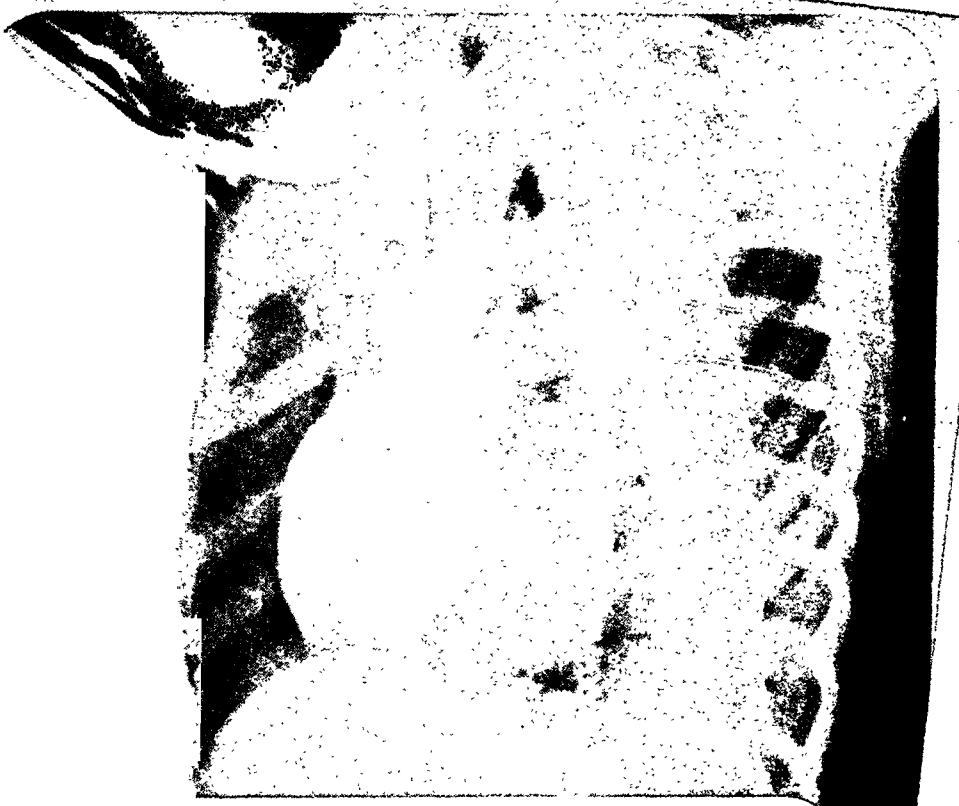
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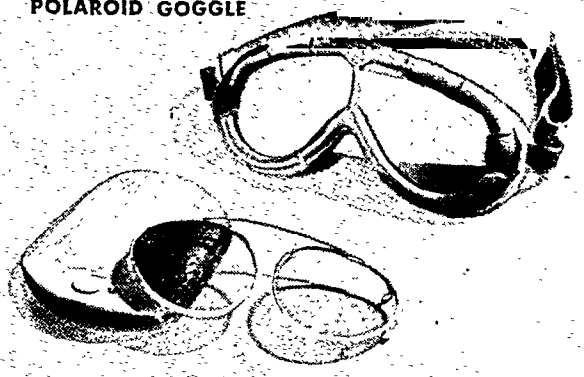
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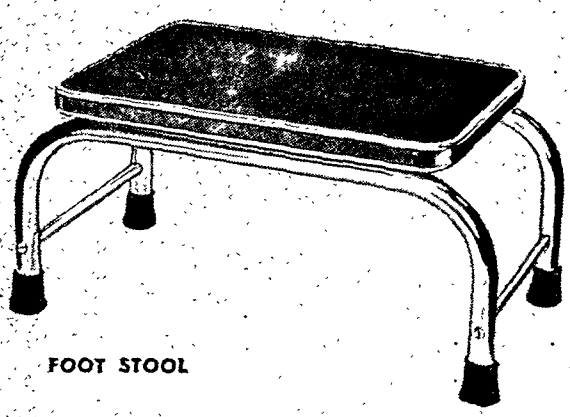
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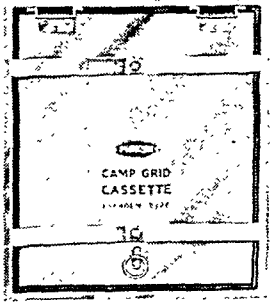
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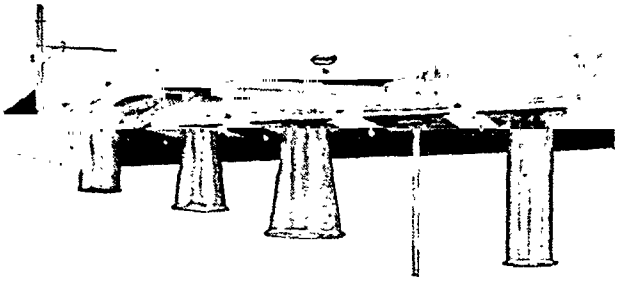
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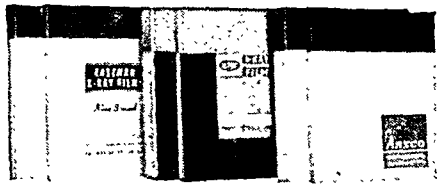




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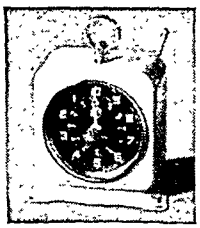


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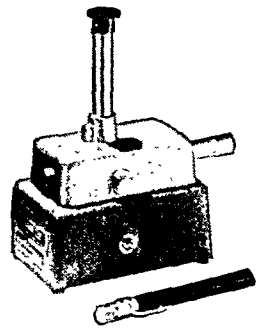
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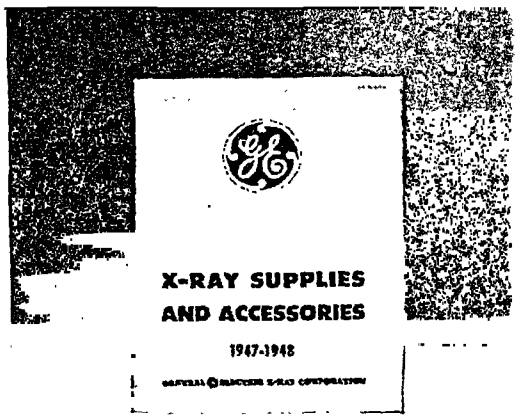
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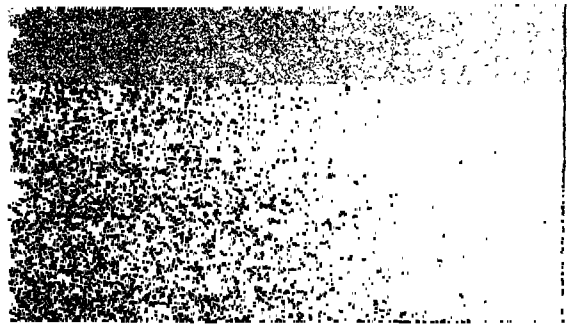
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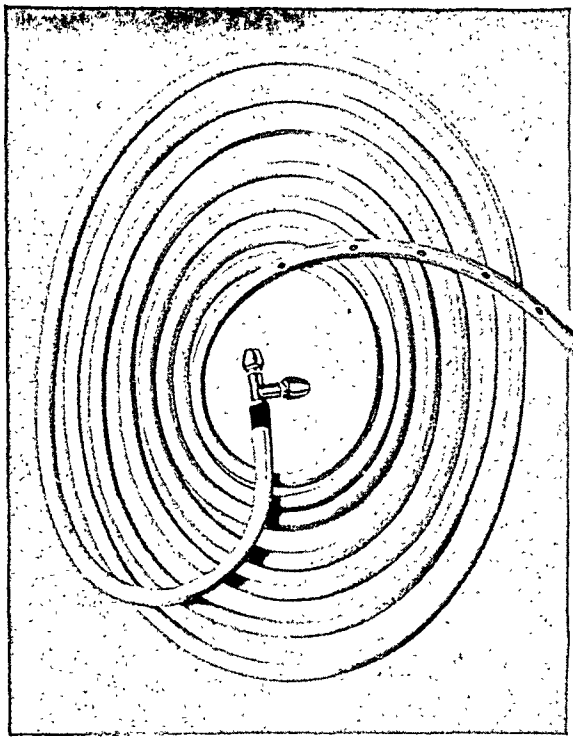
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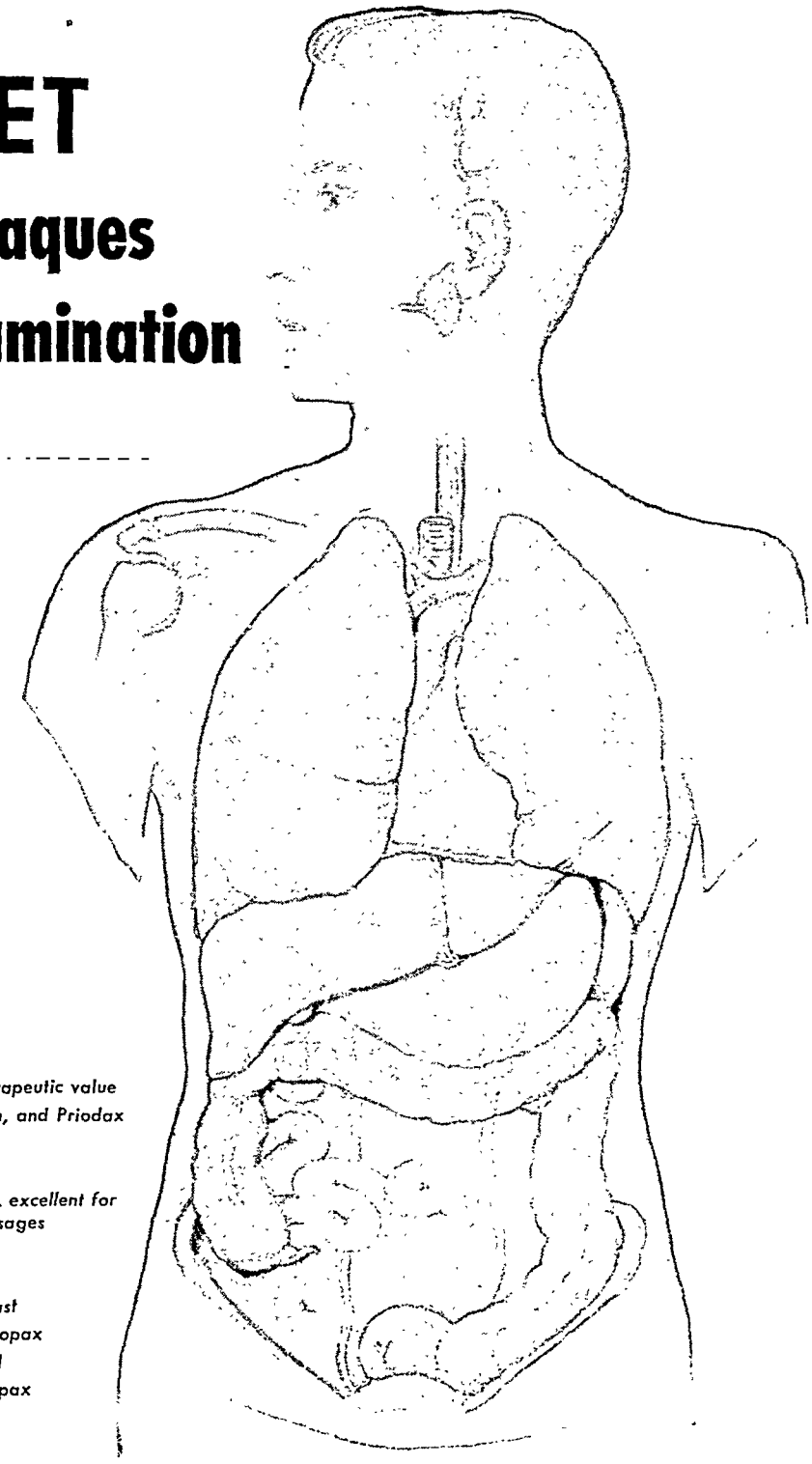
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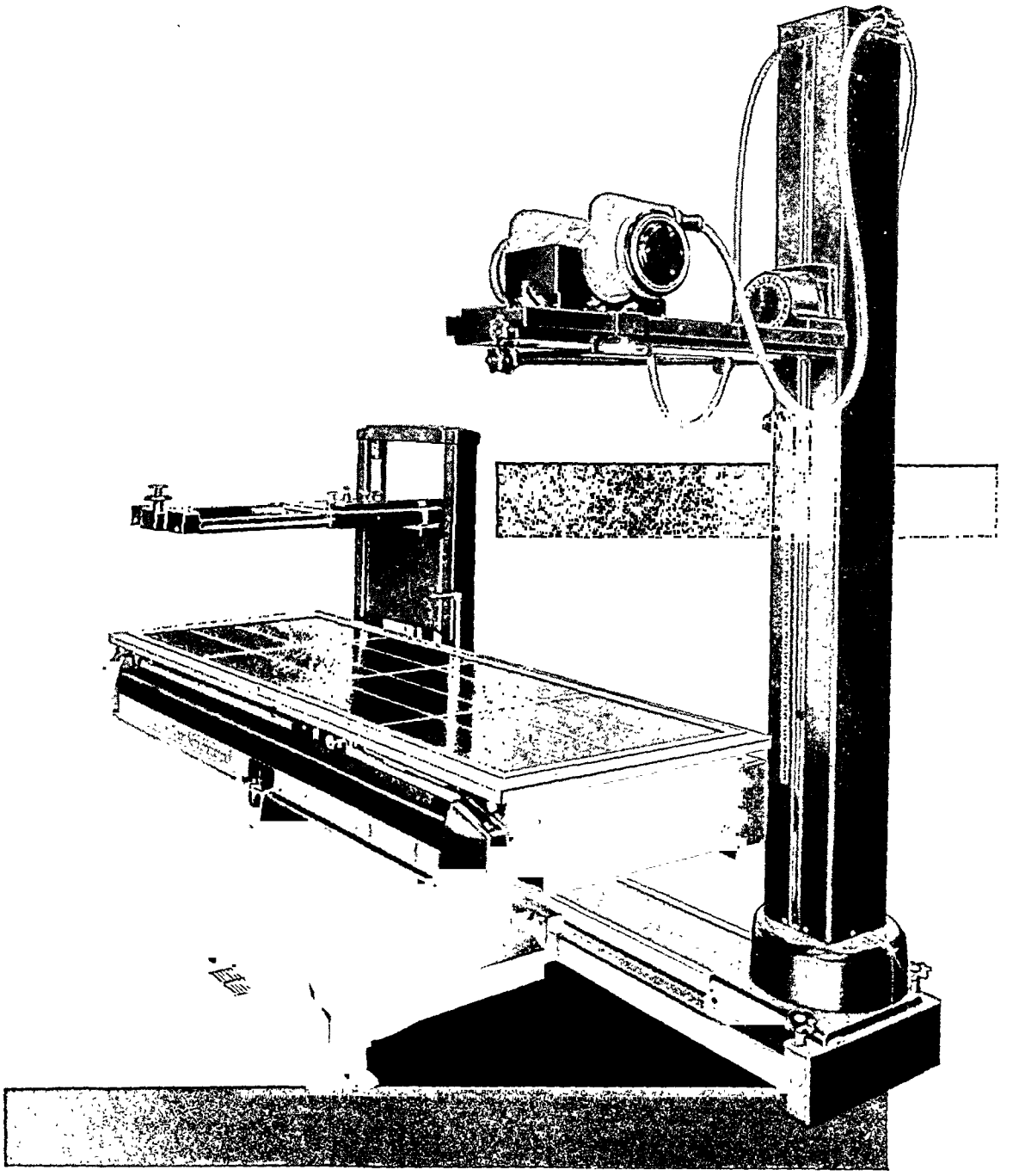
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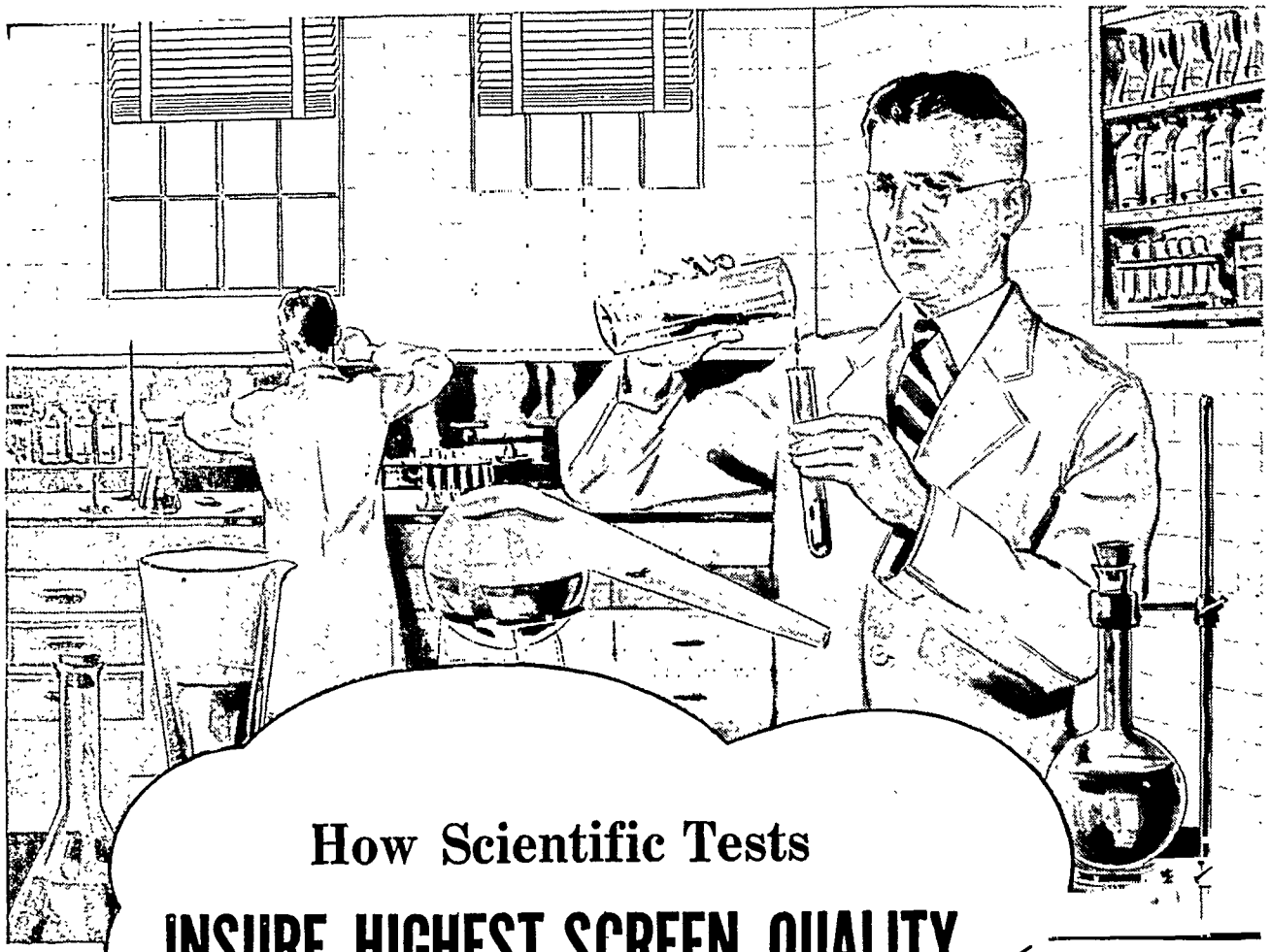
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VOL. 60 SEPTEMBER, 1948 NO. 3

PNEUMOENCEPHALOGRAPHY IN THE DIAGNOSIS OF CEREBELLAR ATROPHIES*

REPORT OF FIVE CASES

By L. UZMAN, M.D.
WAVERLEY, MASSACHUSETTS

THE diagnosis of primary cerebellar atrophy usually offers little difficulty in cases where the gradual evolution of cerebellar ataxia chiefly affecting the gait is not associated with any evidence of affection of other systems or of any disorder of the cranial nerves. Such a conclusion is, however, reached by a process of exclusion of which the disadvantages become apparent when an unusual feature, such as, for example, a sudden onset following trauma, complicates the picture. Even a final autopsy verification of diagnosis is seldom attained, owing to the prolonged course of the illness.

The pneumoencephalographic findings on patients suspected of having primary atrophy of the cerebellum, but in whom intracranial neoplasm could not otherwise be excluded, seemed to suggest that air studies may serve as a useful adjunct in establishing an in vivo confirmation of the diagnosis of primary cerebellar atrophy. In the 5 cases presented here, the diagnosis could be established on clinical data alone but pneumoencephalography gave satisfactory confirmation.

Although the pneumoencephalographic picture presented by cerebellar atrophies has been previously commented upon, it seems pertinent to point to the paucity of reports of the use of this method of demonstrating a reduction in size of the cerebellum. Some[1] who have advocated the method have overlooked the difficulty presented by the fact that reduction in size of the cerebellum is not always in proportion to the intensity of symptoms. In the primary lamellar atrophy, the shrinkage of the cerebellum is slight and the disorder demonstrable only by the loss of Purkinje cells on microscopic examination of the cerebellum, whereas the clinical disturbances may have been quite severe. On the other hand, cerebellar agenesis and hereditary primary atrophy may show minimal clinical disturbance until a fairly advanced stage of the disease, though the pathologist finds only a vestigial cerebellar remnant has been present. Just as the actual loss of cerebellar cortex does not indicate any proportional loss of cerebellar function, so the apparent size of the cisterna cerebellomedullaris, as seen on a lateral film, does

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not necessarily give a true indication of the real size of the cerebellum in relation to the posterior fossa. The occasional uneven density of the falx cerebelli, restriction of the atrophy to the cerebellar hemispheres with relative integrity of midline structures, may easily lead one to miss the loss in cerebellar substance if this be judged solely on the basis of the apparent air content of the posterior fossa as seen on a single lateral film. Only a systematic study of infratentorial air pockets in stereoscopic anteroposterior, posteroanterior and lateral views will give a true picture of the depth and extent of these pockets, and hence, indirectly, indicate the extent of actual loss in cerebellar mass. Thus the presence of pneumoencephalographic evidence of cerebellar atrophy will act as a confirmation of the clinical diagnosis, whereas its absence can only be taken as suggesting that the parenchymatous degeneration might only be of an extent determinable by microscopic study. The clinical diagnosis can only be confirmed but not negated by encephalographic evidence.

The clinical criteria for differentiating one type of progressive cerebellar atrophy from another are quite unreliable and at best only presumptive. The clinical differential diagnosis is, as Déjérine puts it, "des plus délicats et rien n'est plus malaisé que de l'établir." We have no evidence of encephalographic criteria to aid in the differentiation though, on anatomical grounds, slight enlargement of the prepontine cistern might be expected to corroborate the presence of olivo-ponto-cerebellar degeneration. Among the cases presented here, Case I was considered tentatively to belong to the class of olivo-ponto-cerebellar degeneration, and encephalography did show a slight enlargement of the prepontine cistern. However, a similar enlargement was also present in 2 (Cases II and V) of the other cases. Thus, a definitive classification of the "type" of parenchymatous degeneration in considering any individual case still falls mainly within the domain of neuropathology.

TECHNIQUE

Since our avowed interest focussed on obtaining a complete visualization of the whole subarachnoid space and the structures outlined by it, it was consequently imperative that one should resort to a very thorough replacement of the fluid within these spaces by air. Thus in all 5 cases reported 160–220 milliliters of spinal fluid was withdrawn by the lumbar route and replaced by air without the application of positive pressure, the actual amount of the removable fluid quantity depending on the free flow of fluid under good pressure, on the patient's degree of discomfort, and on any change in vital signs. Proper premedication, in our opinion, is of paramount importance in preventing the patient's suffering any undue discomfort and in ensuring the safety, of what might otherwise seem a drastic procedure, even in patients whose age and physical condition (Case V) might have been deemed a contraindication.

The procedure followed was essentially that outlined by von Storch.[4] Nembutal 0.2 gram and morphine 10 mg. subcutaneously was given one-half hour prior to the lumbar puncture. Twenty minutes later atropine sulfate 0.6 mg. was administered by the same route. If this premedication resulted in a considerable fall in blood pressure, this was remedied by ephedrine sulfate 50 mg. given intramuscularly. Lumbar puncture was performed in the sitting position. The fluid was allowed to escape under its own pressure into a large syringe held horizontally, displacing the piston. Each removal of 10 milliliters of fluid was followed by replacement with 10 ml. of air, this procedure being repeated until the estimated quantity was reached. After each injection of air, the head was moved laterally, anteflexed and retroflexed, to allow the air free admission to the various basal cisterns and then to distribute itself evenly throughout the subarachnoid space. As soon as the required amount of fluid was replaced, the lumbar needle was withdrawn and anteroposterior, posteroanterior, right

and left lateral stereoscopic films were taken, usually with the patient in the recumbent position.

The headache resulting from the procedure was controlled by raising the foot of the bed, forcing fluids and giving codein and aspirin, and in all 5 cases the headache had disappeared within four to eight hours.

The procedure described by Robertson[3] for the visualization of the cerebellum carries two distinct advantages, i.e., a more direct view of the whole cerebellar silhouette, and the use of much smaller amounts of air, thus reducing the patient's discomfort to a minimum. Although we have not used this method, it does seem to recommend itself in cases where encephalography is resorted to with the sole purpose of demonstrating atrophy of the cerebellum and should find more widespread use in the future.

REPORT OF CASES

Case 1. C. L., Male, white, aged thirty-eight, electrician, was admitted to the Neurological Service of the Boston City Hospital on May 9, 1946, with the chief complaints of slurring of speech for five years, and diplopia and unsteadiness of three years' duration. The difficulty with his speech came on very insidiously, being first noticed by his friends who complained that the patient spoke "as if he had a hot potato in his mouth." The words were slurred, indistinct, and gradually assumed an explosive quality. About three years prior to his present admission the patient noticed the onset of transient episodes of diplopia, usually initiated on attempting to focus for some time at a distant object. These episodes would only last for a few minutes. At about the same time the patient noticed that his body would sway from side to side while he shaved in front of the mirror. Over the next two years this unsteadiness while standing gradually progressed, affecting also his gait and making it impossible for him to walk on a straight line. Friends who witnessed his staggering and unsteady gait had often unjustly accused him of being inebriated. During all this time there was no gross unsteadiness in the movements of his upper extremities. Five months prior to admission the onset of occasional brief episodes of dizziness when the patient lay flat on his back, made their appearance. At no time was there any headache, nausea or vomiting. There had never been any blurring of vision nor were paresthesias ever noticed. Bladder, bowel and sexual functions had always been normal.

Past history: The patient volunteered the information that since early childhood he had always had great difficulty in performing fine coordinated movements with his fingers, such as fitting a small screw into a little hole, etc. The use of alcohol was denied.

Family history was entirely negative for neurological disorders of any kind.

Examination on admission to the service disclosed a well nourished, well developed man, anxious to cooperate and quite reliable. The general physical examination was entirely negative. The blood pressure was recorded as 135/90 mm. On neurological examination the slurring of speech was most conspicuous. The words were at times unintelligible. His speech had an explosive quality trailing off at the end of a phrase in a slurred diminuendo. The pupils were equal, reacted to light and on accommodation. The fundi were entirely normal. Extraocular muscles functioned normally, and there was no nystagmus. The tongue was in the midline, showed no tremor or atrophy. The rest of the cranial nerves were normal. There was no weakness of any of the extremities. Reflexes were generally hyperactive but bilaterally equal. The plantar responses were flexor. No sensory impairment could be demonstrated, position and vibration sense also being intact. Finger-to-nose test showed bilaterally a very slight tremor at the end of motion. There was no past-pointing. Alternating movements were poorly performed. The heel-to-shin test showed a slight bilateral dysmetria. The patient walked with a broad base, was unable to walk on a straight line without swerving to one side or the other, and seemed to take great care in turning around, this movement being executed with studied care, the whole trunk and hips moving simultaneously as if placed in a suit of armour. Romberg's sign was absent.

Blood and urine studies were entirely within normal limits. Blood Hinton was reported negative. Non-protein nitrogen 30 mg. per cent. Lumbar puncture showed an initial pressure of 150 mm. water; the fluid was clear, colorless and contained no cells; Pandy test negative, total protein 14 mg. per cent, chlorides 711 mg., and

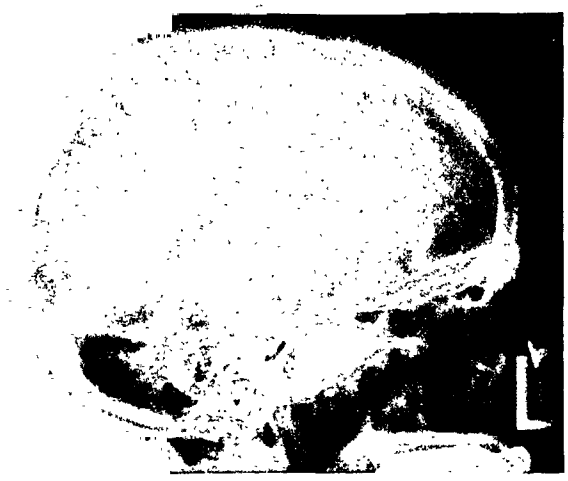


FIG. 1. Case 1. Lateral roentgenogram.

the gold-sol curve was flat. Spinal fluid Hinton and Wassermann reactions were reported as negative.

Roentgen examination of the skull, cervical spine, chest and abdomen was entirely negative.

A pneumoencephalogram was performed with the removal of 170 ml. of fluid without noticeable discomfort to the patient (Fig. 1, 2 and 3).

Patient was discharged on May 29, 1946.

CASE II. W. W., single, white, unemployed male, aged thirty-eight, was admitted to the Service on September 7, 1946, with a six year history of weakness of his legs. The patient had been a neurotic child with "asthma" up to the age of fourteen, and enuresis lasting up to the age of eighteen. About twenty years before his present admission the patient had become a confirmed alcoholic. However, it was only about six years prior to admission that he noticed the onset of unsteadiness in walking. His legs began to feel weak, and he had to walk with a broad base to avoid reeling and staggering from side to side. This unsteadiness progressed over the next three years to the point where the patient could not walk without support. There was no associated weakness or unsteadiness of the upper extremities. Headaches vertigo, nausea and vomiting were denied.

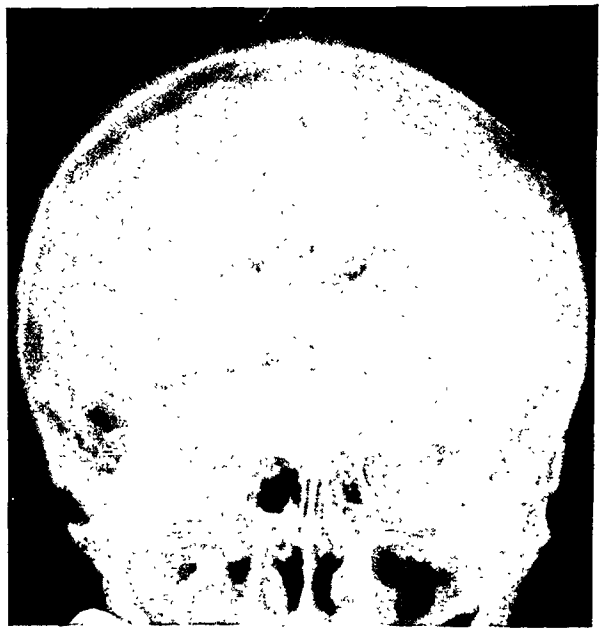


FIG. 3. Case 1. Posteroanterior roentgenogram.

There was no disturbance of bladder, bowel or sexual functions.

The past history was negative except for several hospital admissions for treatment of acute alcoholism, the diagnosis of cirrhosis of the liver having also been established during one of these hospitalizations two years prior to the present admission.

The family history was non-contributory.

Examination of the patient disclosed an obese, sullen male in no discomfort. The general physical examination disclosed atrophy of the papillae of the tongue which had a magenta color, and enlargement of the liver which could be felt four fingers below the right costal margin, being smooth, hard, and non-tender.

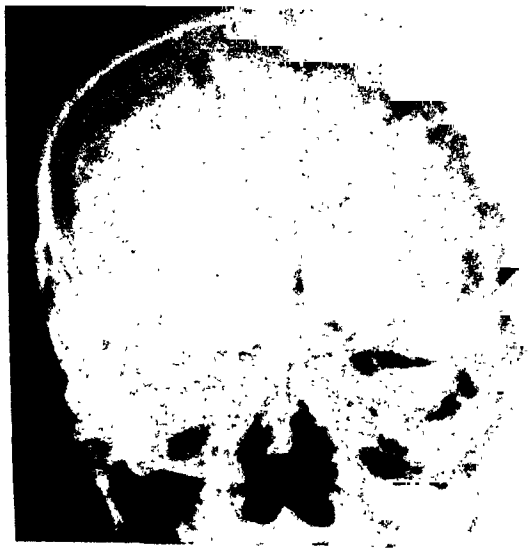


FIG. 2. Case 1. Anteroposterior roentgenogram.

The neurological examination showed no abnormalities of pupils, eye-grounds or of the cranial nerves. There was no nystagmus. The strength of all four extremities was normal. There was no demonstrable hypotonia. Reflexes were hyperactive and equal throughout except for an absent right ankle jerk. Plantar responses were flexor. No sensory loss could be demonstrated. Position and vibratory sense were intact. Romberg's sign was absent.

The patient had a fine tremor of the head in both the anteroposterior and lateral planes. There was titubation of the trunk and slight intention tremor of the upper extremities in the finger-to-nose test. Alternating movements were very poorly performed. The heel-to-shin and toe-to-object tests showed gross ataxia. The patient walked with a broad base and reeling gait, occasionally reaching out for support to keep himself from falling down.

Blood and urine studies were within normal limits. The blood Hinton test was negative. Lumbar puncture showed an initial pressure of 120 mm. of water, no cells, negative Pandy test and gold-sol curve, total protein of 14 mg. per cent. The cerebrospinal fluid, Hinton, and Wassermann tests were also reported as negative.

A pneumoencephalogram was done after removing 220 ml. of fluid, without any discomfort to the patient (Fig. 4).

The patient was discharged September 24, 1946, his condition being essentially unchanged.

Case III. D. B., male, white, unmarried, clerk, aged sixty-one, was admitted to the Neurological Service of the Boston City Hospital with a history of progressive unsteadiness of his legs, this condition having had an insidious onset about one year prior to the present admission. The unsteadiness was limited to the lower extremities and was not associated with any weakness. Although minimal at the beginning, being only noticed while stepping on and off side-walks, the unsteadiness progressed over the period of a year to the extent that walking became quite difficult, and the patient often found himself staggering from side to side. At no time was there any headache, vertigo, nausea, vomiting or difficulty with speech. There were no associated paresthesias, shooting pains or motor weakness. About six months prior to admission, the patient began to have difficulty in emptying his bladder. This became



Fig. 4. Case II. Lateral roentgenogram.

progressively worse. On admission to the Boston City Hospital, Genitourinary Service, he was found to have a marked prostatic hypertrophy. A transurethral prostatectomy yielded 16.5 grams of tissue which was identified as adenocarcinoma of the prostate on histopathological examination. Immediately before his admission to the Neurological Service a bilateral orchidectomy was also performed and the patient was put on stilbestrol.

There was no history of ingestion of alcohol.

The family history was negative for neurological disorders of any kind.

At the time of the patient's admission for neurological review on September 25, 1946, he had almost completely recovered from the operative procedures of which some local edema of the penis and scrotum were the only residual signs.

The general physical examination disclosed an emaciated, elderly male in no discomfort. The skin was pale and dry. There was an old injury of the right eye with resulting opacity of the lens, a fixed right pupil and almost complete amaurosis on that side. The rest of his physical examination was negative except for the physical sequelae of prostatectomy and bilateral orchidectomy. The blood pressure was 150/90.

His neurological examination showed absence of the pupillary reflexes on the right side due to the old injury. The left pupil reacted normally to light and on accommodation. Fundi and visual fields were normal. There was no nystagmus. The cranial nerves were intact. No weakness of any of the extremities was noticed.

Biceps, triceps, radial and knee jerks were bilaterally equal and normal. The left ankle jerk was absent. Plantar responses were flexor. Abdominal and cremasteric reflexes were present and equal. No sensory loss could be demonstrated. Vibratory and position sense were also intact. Romberg's sign absent. The finger-to-nose test was well performed bilaterally. No adiadokokinesis was evident. The heel-to-shin and toe-to-object tests were, however, very poorly performed, with marked ataxia and action tremor. The gait was broad based and ataxic, walking on a straight line being impossible. When asked to stand perfectly still, a tremor of the head and titubation of the trunk became quite evident.

Examination of the blood showed a red cell count of 3.35 million, white cell count of 7,150, hemoglobin 60 per cent, with a differential count of polymorphonuclears 75 per cent, lymphocytes 24 per cent, monocytes 1 per cent. The blood Hinton test was negative. Non-protein nitrogen 50 mg. per cent, and serum total protein 5.58 grams per cent.

Urine analysis showed a clear yellow urine giving an alkaline reaction, with a specific gravity of 1.010, one plus albumin, no sugar, and with large amounts of leukocytes in the urine sediment.

Lumbar puncture disclosed an initial pressure of 180 mm. of water, with free dynamics. The fluid contained 8 red blood cells, no white blood cells, the Pandy test was negative, the total protein 11 mg. per cent, the gold-sol curve was flat, and the Hinton and Wassermann tests were reported as negative.

Roentgen examination of the chest showed no metastases, the heart was not enlarged but the aorta was tortuous and markedly sclerotic. There was an irregular, mottled density involving the second lumbar vertebra, the right pubis, ischium and ilium, consistent with metastatic carcinoma.



FIG. 5. Case III. Lateral roentgenogram.

Pneumoencephalography was performed with the removal of 180 ml. fluid. The patient suffered minimal discomfort consisting of a headache which persisted for eight hours (Fig. 5).

After the subsiding of his penile and scrotal edema, the patient was discharged on November 22, 1946, to a nursing home for terminal care.

CASE IV. P. Z., single, unemployed, Russian-born, white male, aged fifty-nine, was admitted to the Neurological Service of the Boston City Hospital on January 19, 1947, with a history of "nervousness" of six years' duration. The patient was allegedly quite well up to six years prior to his present admission when he noticed the onset of a coarse tremor of both hands becoming evident only when he tried to use his hands. He had difficulty in writing and in using his tools properly. He never seemed to be able to hammer a nail because he always missed the nailhead by striking the hammer to one side or the other of the intended spot. About the same time a slowness and stiffness of gait was noticed which had progressed consistently over the subsequent years rendering the patient quite ataxic, with staggering and occasional reeling to one side or the other. These symptoms had been getting progressively worse. For the past six years he had also experienced paresthesias described as water dribbling down his legs or ants crawling down his thighs. These had only been noticed at night time and lasted about a minute, allegedly coming on almost every night. There have been no headaches, vertigo, weakness, nausea or vomiting.

The patient had been using alcohol in considerable amounts up to the time of onset of his neurological symptoms.

The family history was non-contributory.

The general physical examination revealed a deviation of the trachea to the right with impaired resonance over the right apex anteriorly. Otherwise the physical findings were essentially normal. Blood pressure was recorded as 154/94.

On neurological examination the pupils were found to be equal and reacted normally to light and on accommodation. There was no nystagmus. The fundi and visual fields were normal.

The cranial nerves appeared to be intact.

The strength of the extremities was normal and equal. The biceps, triceps, radial patellar reflexes were equal and slightly hyperactive; the ankle-jerk on the right, however, was slightly less active than the left. Abdominal and cremasteric reflexes were present. The plantar responses were bilaterally flexor. No sensory loss could be demonstrated. Position and vibratory senses were intact.

The patient was noticed to have a rapid rhythmical tremor of the head, exaggerated by voluntary movements of the head. There was a coarse terminal tremor of the arms and hands during the performance of the finger-to-nose test. Alternating movements were very poorly performed. Past-pointing and the rebound phenomenon could be easily elicited with the usual tests. A generalized hypotonia of muscles, especially of the upper extremities was noted. The heel-to-shin test and the toe-to-object test showed definite cerebellar-type ataxia and dysmetria. The gait was broad based and unsteady. Walking on a straight line was not possible. Attempts at running were consistently defeated by the loss of balance and excessive staggering.

Blood and urine studies were entirely within normal limits. The blood Hinton was negative, and the non-protein nitrogen 34 mg. per cent.

Lumbar puncture revealed a clear fluid with an initial pressure of 70 mm. of water. It contained no cells, the Pandy test was negative, the gold-sol curve was flat, the total protein was 29 mg. per cent, with negative Hinton and Wassermann tests.

Roentgenograms of the chest and skull were negative.

Pneumoencephalography was undertaken with the removal of 210 ml. of spinal fluid and replacement by air (Fig. 6 and 7).

The patient was discharged on January 27, 1947, without any change in his original condition.



Fig. 6. Case iv. Lateral roentgenogram.

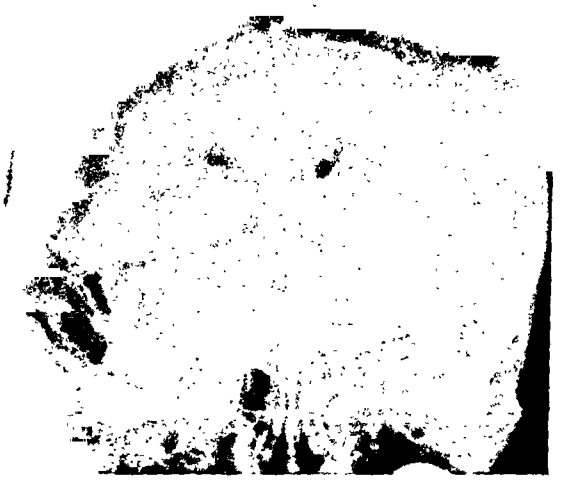


Fig. 7. Case iv. Posteroanterior roentgenogram.

Case v. J. H., a single, white male, aged seventy, was admitted to the Neurological Service of the Boston City Hospital on January 24, 1947, with a twenty year history of shaking of his hands and unsteadiness of his legs. The disease had begun insidiously, first noticed as a tremor of the hands as the patient reached out for objects. Soon unsteadiness in walking, occasional staggering, and swaying of the trunk while sitting made their appearance. There was no concomitant weakness, pain or headache. The disease had progressed steadily and had become very much worse about a year prior to admission, so that walking and shaving had become very difficult. The patient also complained of hoarseness developing over the period of one year. He also admitted a gross loss of memory for recent events, but could not indicate the time of onset of this symptom.

The past history was entirely negative. Ingestion of alcohol was denied.

The family history was non-contributory.

Examination disclosed a well developed, slightly emaciated white male, who showed the general ravages of senescence. Blood pressure was 142/56. The skin was atrophic and there was a mycotic infection of the toes. Marked

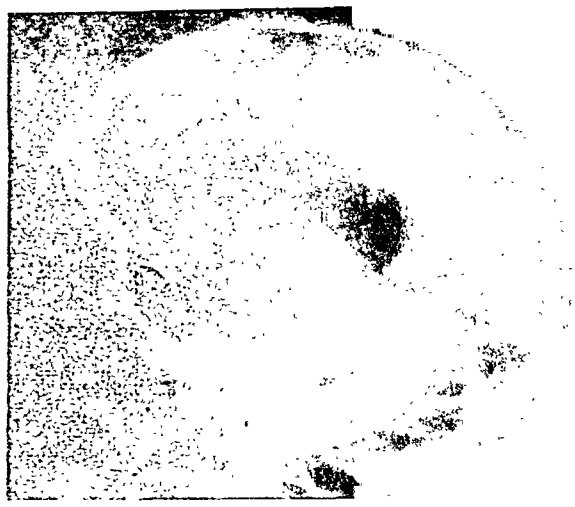


FIG. 8. Case v. Lateral roentgenogram.

generalized arteriosclerosis was evident. The cranial nerves were intact. There was no nystagmus. Laryngoscopic examination disclosed paralysis of the interarytenoid muscles with bilateral adductor palsy. Motor power was well preserved in all four extremities. Reflexes were bilaterally hypoactive, the ankle-jerks being absent. The plantar responses were flexor. Position and vibratory sense were reduced below the knees; otherwise there were no sensory changes. The patient presented the following evidences of cerebellar disease: there was a tremor of the head in the anteroposterior and lateral planes, this being markedly accentuated during walking. A coarse action tremor was evident in both upper extremities, not being limited to the hands but being also initiated at the elbow and shoulder. Adiadokokinesis was present as was also the rebound phenomenon. The heel-to-shin and toe-to-object tests disclosed gross ataxia in the legs. The gait was broad based, with occasional staggering and reeling from side to side. Attempts at walking on a straight line were constantly foiled by this unsteadiness.

Blood and urine studies were normal. The blood serology was reported as negative. Examination of the spinal fluid was entirely negative.

Roentgen examination of the skull and chest was negative.

Pneumoencephalography was undertaken after the usual premedication (Fig. 8); 120 ml. of fluid was removed and replaced with air. The patient recovered from the procedure uneventfully and was discharged on February 18, 1947, without any change in his condition.

Pneumoencephalography. Case I. The lateral ventricles are symmetrical, normal in size, and show no displacement (Fig. 1, 2 and 3). The third ventricle occupies its normal position in the midline. The aqueduct and fourth ventricle visualized in the lateral films are normal. The supratentorial subarachnoid markings are well outlined, indicating a possibility of diffuse cortical atrophy. The prepontine and perichiasmatic cisterns are well defined and large. Immediately under the tentorium there is an unusually large collection of air outlining the rostral or superior surfaces of the cerebellar hemispheres which present a rather pronounced concavity (Fig. 2 and 3) in contrast with the gentle ellipsoid slope that characterizes the superior contour of the normal cerebellum. The lateral films depict the relationship between the semilunar lobes and the dural lining of the posterior fossa. The maximum distance between cerebellum and bony density reaches 14 millimeters at one point. This space is continuous with the cisterna cerebello-medullaris which is about twice the normal size. The anteroposterior view emphasizes the reduced density below the tentorium. The whole picture is one of pronounced atrophy of the cerebellum.

Pneumoencephalography. Case II. There is a uniform dilatation of both lateral ventricles without any displacement. The third ventricle is moderately dilated but occupies its normal position in the midline. The supratentorial subarachnoid markings are slightly accentuated, indicating a moderate amount of cerebral cortical atrophy. The basal cisterns are rather large, as is the prepontine cistern. The posterior fossa holds an unusually large amount of air, the cerebellar silhouette being clearly outlined over its inferior surface by a large pocket which is continuous with the cisterna cerebello-medullaris beneath it (Fig. 4). The maximal distance between the inferior cerebellar surface and the cranial diploe opposite it is 14 mm. as measured on a lateral film. It was concluded that a definite reduction in size of the cerebellum had taken place, though the subtentorial space was not outlined as in Case I.

Pneumoencephalography. Case III. The lateral ventricles are symmetrically enlarged and show no displacement. The third ventricle is in the midline and perhaps slightly wider than usual. The subarachnoid markings over the surface of the cerebral hemispheres indicate a moderate degree of cortical atrophy. The posterior fossa is well filled with air, demarcating a definite enlargement of the cisterna cerebello-medullaris

both in width as well as in depth (Fig. 5). The infratentorial air pockets are also definitely larger than commonly seen, the whole picture being consistent with cerebellar atrophy.

Pneumoencephalography. Case IV. Both lateral ventricles are symmetrically and uniformly dilated, without any displacement or distortion. The third ventricle is in the midline and moderately enlarged. The cerebral sulci do not appear wider than usual and there is no evidence of cortical atrophy.

In the lateral view the superior surface of the cerebellum has lost its normal rounded silhouette and presents a concave surface (Fig. 6). In anteroposterior and posteroanterior views (Fig. 7) the amount of air between tentorium and cerebellum appears of normal, or only slightly increased, amount. The lateral recesses of the posterior fossa show large collections of air, indicating a definite reduction in size of the cerebellum. This atrophy is further emphasized by the accentuation of the individual outlines of the cerebellar fissures. The cisterna cerebellomedullaris is about twice the normal size, and there is a large collection of air between the inferior surface of the cerebellar hemispheres and the inner diploe of the occiput, the greatest distance between these being at a point 20 mm. beneath the tentorium where the cerebellodiploic space is measured as 15 mm. on the lateral film. Examination of the stereoscopic lateral films gave a clear view of the shrunken cerebellar outline in relation to the posterior fossa.

Pneumoencephalography. Case V. There is a symmetrical uniform enlargement of the lateral ventricles without any displacement. The third ventricle occupies its normal position in the midline and is dilated, slightly globose in shape. Widening of the sulci and the wide spacing that demarcates the insula shows the presence of marked cortical atrophy, the corresponding loss in white matter being reflected in the enlargement of the ventricular system. The interpeduncular and perichiasmatic cisterns are markedly enlarged, as is the prepontine cistern. The lateral stereo films emphasize decrease in the size of the pons. The posterior fossa is not fully occupied by the cerebellum. The cisterna cerebello-medullaris is unusually large, its lateral depth being accentuated by loss of cerebellar substance of the hemispheres (Fig. 8). The space between tentorium and upper surface of the cerebellum is doubtfully if at all enlarged. Stereo lateral films show a very clear demarcation of the folia cerebelli with large collections of air outlining each quite clearly, the primary and secondary fissures of the cerebellum being well defined. This appears as ample evidence of the parenchymatous degeneration of the cerebellum, although the total amount of subtentorial air, as observed on lateral views, appears to be less than that present in the previous cases.

DISCUSSION

The symptomatology of all 5 cases was more or less similar. The common features may be summarized as follows: The gradual onset of symptoms in males of middle age (except in Case I where the disease had its onset at the age of thirty) with no history of similar disturbance in other members of the family. The most common complaint was difficulty in walking with reeling and staggering in the more severe cases. Cerebellar asynergia, dysmetria and tremor were minimally present in the upper extremities of all 5 cases, these signs, however, being most conspicuous in the legs. In none of the cases was there any nystagmus. Dysarthria was observed in only 1 of the cases (Case I). All the patients walked with a broad base. The reflexes were recorded as normal except for an absent ankle-jerk in Cases II and V. In view of the assumptions previously made by Romano, Michael and Merritt[5] regarding the probable alcoholic etiology of cerebellar atrophy, a most careful scrutiny of the habits of the patients was undertaken. In only 2 of the cases (Cases II and IV) could any intake of alcohol be established. The other 3 patients were more or less confirmed abstainers. Dietary histories were also negative as to providing any possible etiologic clues. Mental deterioration was observed in Case V, in a patient who was quite senile and demonstrated advanced arteriosclerosis. In none of the patients was there any evidence of syphilis. All the patients were males, and this is also in keeping with the reports of Rossi,[6] Marie, Foix and Alajouanine,[7] and Romano, Michael and Merritt.[5]

The encephalographic findings in the 5 cases reported also showed numerous char-

acteristics common to all. The cerebral ventricular systems were uniformly enlarged in 3 cases, this enlargement being most conspicuous in Cases III and V. There was a slight degree of cerebral cortical atrophy in Cases II, III, and V. The cisterna cerebello-medullaris was enlarged in all 5 cases, this being most marked in Cases I, III, and IV. Enlargement of the perichiasmatic and prepontine cisterns was observed in Cases I, II and V while Case IV showed unusually large air pockets in the lateral recesses of the posterior fossa. Besides the increase in the size of the normally present basal posterior fossa cisterns as an indication of reduction in the size of the cerebellum, Case V displayed another encephalographic criterion by which atrophy of the cerebellum might be surmised. This consisted in an outlining of the individual cerebellar folia by subarachnoid air, and the demarcation of the primary and secondary sulci. The presence of the encephalographic picture alone, even without any increase in the size of the posterior fossa cisterns, appears as definitely indicative of extensive cerebellar cortical atrophy.

The presence of encephalographic evidence for cerebellar atrophy in 5 consecutive cases entering the Neurological Service of the Boston City Hospital within a period of nine months renders the inclusion of encephalographic examination of patients with similar disorders as routine procedure almost a necessity. Thus not only would a confirmation of the clinical diagnosis be provided by a rather simple procedure, but in a larger series may help to correlate the clinical symptoms with the gross anatomical changes taking place within the cerebellum itself during the course of the evolution of the disease.

SUMMARY

Five cases of primary cerebellar atrophy are reported. In every one of these patients, all of whom were males of different national extractions, the disease had appeared insidiously after the third decade of life, without any family history of similar neurological affection. In only two of the cases could the use of alcohol be established. There was no evidence whatsoever to indicate that any of the patients had ever had syphilis. Encephalographic studies in every of these five cases supported the clinical diagnosis in demonstrating a reduction in size of the cerebellum in relation to the posterior fossa. This reduction varied in amount from a slight enlargement of the medullo-cerebellar cistern and increased amounts of accumulated air between the cerebellar folia, to the apparent reduction of the cerebellum to almost two-thirds of its normal mass. Considering the relative paucity of cases of primary cerebellar atrophy in the neurological literature, and the dearth of pathological examinations on those cases actually reported, it is suggested that encephalography might prove useful in confirming a diagnosis which, however accurate and well founded, would otherwise lack direct, objective evidence.

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ACCURACY OF ROENTGEN DETERMINATION OF ACTIVITY OF MINIMAL PULMONARY TUBERCULOSIS

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THE photofluorogram has been welcomed as the solution to the two-fold problem of tuberculosis control: finding the infective source for the purpose of isolating it and finding the early case at a stage amenable to therapeutic measures. Its introduction has, however, raised new questions. At the present time ever larger population groups are being surveyed and constantly growing numbers of "positives" are being discovered with the result that sanatorium and hospital facilities threaten soon to be swamped unless criteria which are reliable, yet simple in application, are shortly established as a guide in the disposition of the newly discovered case.

What to do with the patient with extensive tuberculosis of either the exudative or cavitary types is not the concern of this paper. These are diagnostic problems in only the exceptional instance and their disposition is a problem only in relation to available facilities. What to do with the small non-cavitary lesion discovered during mass surveys is a problem which resolves itself into two components: first, the differential diagnosis; second, the disposition of the case once it has been identified as tuberculous.

The question of differential diagnosis is important because of the great number of non-tuberculous, as well as tuberculous, lesions which will be found in a survey program as extensive as that now being developed. This matter has been the subject of some discussion in recent literature and it has been recommended that no one "attempt to diagnose any pulmonary pathologic condition by x-ray" on the ground that the changes "are not pathognomonic."[7] Others have proposed complex and detailed schemes for the differential diagnosis of "abnormal pulmonary findings" because they consider the diagnosis of pulmonary tuberculosis on the basis of roentgen examination alone "scientifically unsound."[3]

There can be no argument against the routine tuberculin testing of all individuals with abnormal chest roentgenograms. A negative skin test is strong evidence that the lesion is not tuberculous. On the other hand, it must be recognized that a positive reaction in no way simplifies the differential diagnosis since it *excludes nothing*. Those who feel that reactors with roentgen findings can then be divided into active and inactive, or even tuberculous and non-tuberculous categories on the basis of sputum examinations or gastric aspirations take too sanguine a view of the problem, in our opinion. In a sense the converse of the remark about the tuberculin test applies to these examinations. While the *unequivocal* demonstration of acid-fast bacilli is diagnostic, negative sputum examinations and gastric aspirations are no great help. Occasional specimens or series of specimens may be negative in an undoubted or proved case with extensive disease (Fig. 1) and this situation is more likely to be encountered in the smaller lesion. Several reports have recently emphasized that positive findings may sometimes be obtained only by repeating gastric aspirations as many as twelve to eighteen times.[4,5]

The proponents of the disposition schemes based on sputum findings themselves state that not all laboratories are qualified to do such examinations and that certified centers must be established to provide this service.[3] Also, unless collected

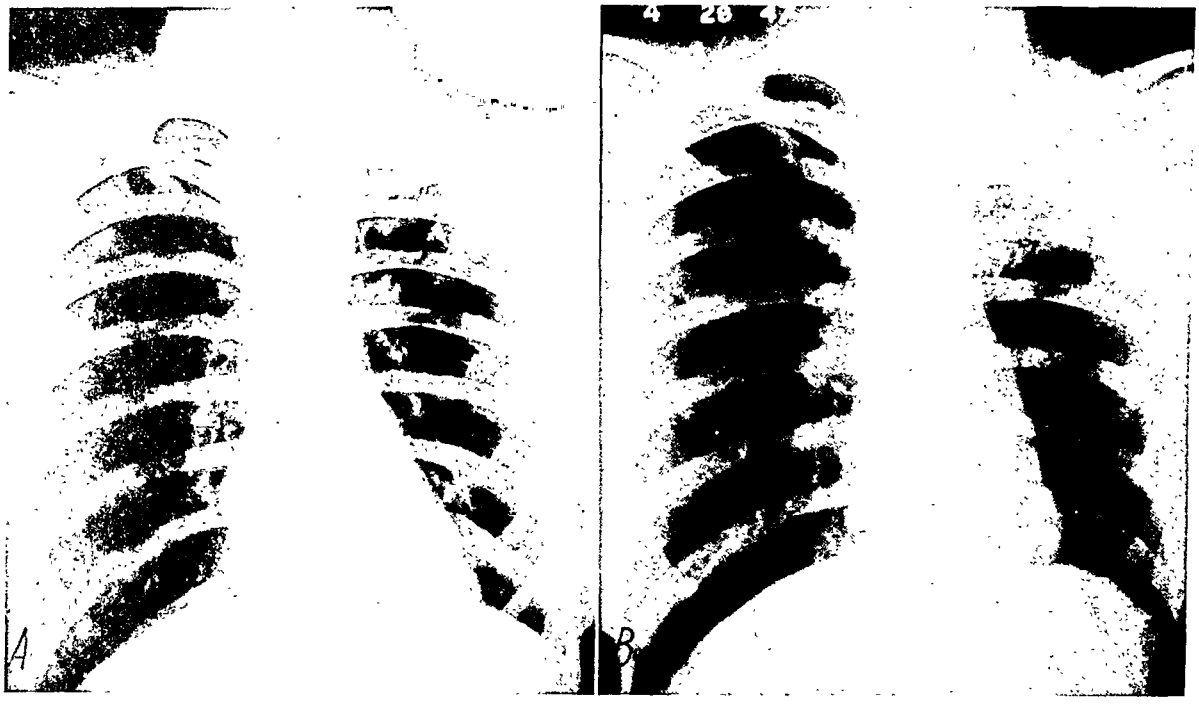


FIG. 1. *A*, active tuberculosis in white female, aged twenty-one, on routine examination. Repeated sputum and gastric examinations negative for four months. *B*, at time streptomycin therapy had begun to prevent irreversible changes. First positive culture reported after streptomycin therapy was initiated.

under some measure of observation there is always the possibility of deliberate substitution of sputums.

Scheduling patients for a number of gastric aspirations presupposes a degree of enlightened cooperation not always encountered in our clinic patients, many of whom are disinclined to return even for follow-up roentgen examinations. In the first five months of 1947, a total of 581 cases of minimal tuberculosis alone were reported by our clinic. Assuming that three successive gastric aspirations would be done on each with negative routine sputums it would be impossible to follow this procedure without a marked increase in staff and facilities.

It has been established that gastric washings deteriorate rapidly and that the percentage of positives obtained drops sharply in the first three days.[9] After seventy-two hours it is no longer worth while to examine such specimens. Where reliable laboratories are not available it would be more feasible to send the roentgenogram to a competent roentgenologist for evaluation than to send sputum or gastric washings. Finally, not the least important shortcoming of the bacteriologic diagnosis of the small pulmonary lesion is the lack of permanently available evidence for restudy and comparison in prolonged follow-up.

It is our purpose to outline the methods employed by the Detroit Department of Health and present an analysis of the results obtained under the difficult conditions encountered during the war years, namely, a shifting industrial population and a shortage of field workers required to maintain an adequate follow-up on diagnosed cases.

METHOD EMPLOYED BY THE DETROIT DEPARTMENT OF HEALTH

Not only is the differential diagnosis made by the roentgenologist but, whenever possible, an opinion as to the activity of the lesion, if tuberculous, is expressed at the time of the initial examination. The disposition, if active, is determined by home conditions and number of beds available

at the time. From the beginning of the period covered in this report to the present time, there has been a substantial number of diagnosed cases in excess of available beds. This, as well as consideration of the social and economic stresses on the families involved, has made it imperative that no facilities be dissipated on any case not definitely active.

1. If the initial roentgenogram is interpreted as showing evidence of an active minimal tuberculosis, that patient should be hospitalized as soon as possible and, if other studies are confirmatory, the therapeutic measures applicable will be employed.

2. If the initial roentgenogram is interpreted by the roentgenologist as showing no evidence of activity but there is evidence of hemoptysis, wheezing, or extrapulmonary tuberculosis the disposition will depend on the clinician's evaluation since the presence of any of these modifies the prognostic value of the roentgenographic findings.

3. If the initial roentgenogram shows an inactive minimal tuberculosis and there are no significant clinical findings, the patient is instructed to return for reexamination in three months. Meanwhile tuberculin and sputum studies should be carried out. The roentgen examination should be repeated at three month intervals for at least two years and thereafter every six months to a year for an indefinite period, possibly the rest of the patient's life. The interval between observations must be shortened and special vigilance will be exercised when hygienic conditions are poor, when the patient is a member of one of the more susceptible racial groups, and during periods of stress such as pregnancy and the period following delivery.

We do not subscribe to the statement that pulmonary roentgen changes are not pathognomonic. Such changes have been described and checked against postmortem findings often enough to establish the roentgen characteristics of tuberculous lesions, and occasions for repeating such correlations continue to arise (Fig. 2). Nor do we entirely agree with the statement recently made that "to attempt to determine the activity of proved tuberculous lesions by a single x-ray shadow is preposterous."[7] Those who have watched far



FIG. 2. *A*, White male, aged forty-four. Interpreted as inactive. Treated elsewhere for "tuberculous adenitis" and finally referred back comatose as "tuberculous meningitis." Autopsy revealed lymphosarcoma, generalized, and obsolete pulmonary tuberculous process. *B*, postmortem inflation roentgenogram.

and moderately advanced tuberculosis regress to small stable remnants under therapy (Fig. 3) know that such lesions have characteristics by which they may be recognized, and realize that such regression frequently occurs unobserved in the undiagnosed case. It is our estimate that more than 75 per cent of all *minimal* lesions seen by us in surveys have acquired stability at the time they are first observed. Acquired in a short course of film interpretation is required in reading even survey roentgenograms. Some recent surveys have been conducted by interpreters who were not fully qualified radiologists.[6]

The tuberculous lesion in its earliest form is typically a small unilateral soft snowflaky process commonly found in the upper half of either lung (Fig. 4). A little later similar soft shadows may appear on

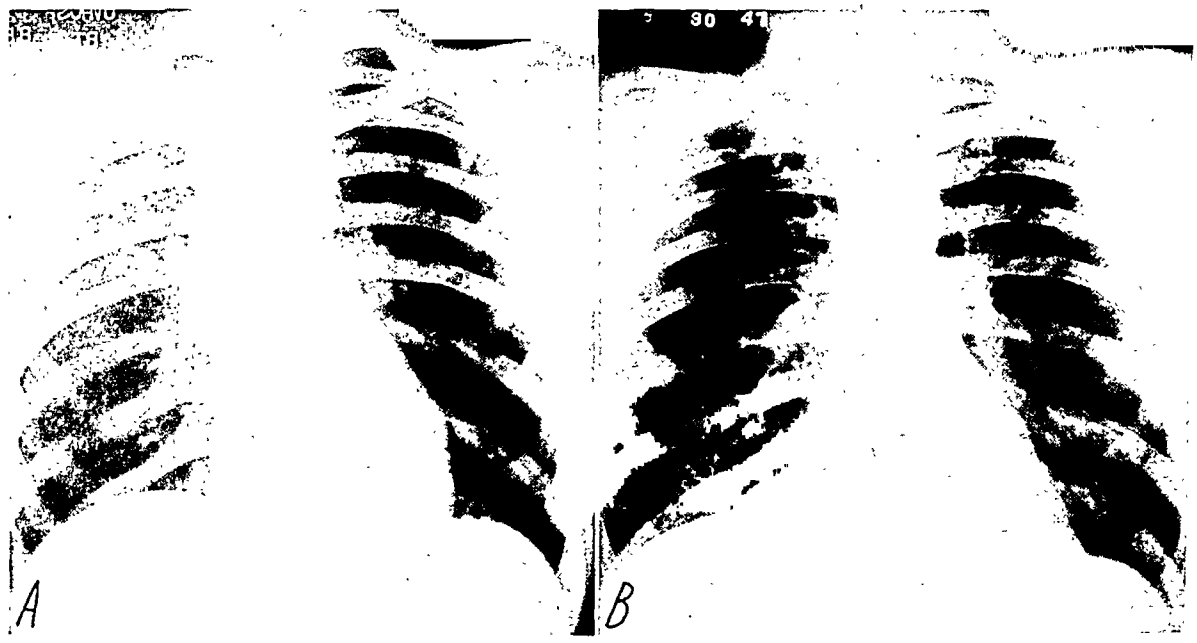


FIG. 3. *A*, active excavating disease in white male, aged twenty-two, in 1934. Pneumothorax for four years. Regressed sufficiently to be acceptable for full duty in Pacific with Armed Forces. *B*, present small remnant.

tually 90 per cent of the 581 cases of minimal tuberculosis reported by this clinic in the first five months of 1947 were interpreted as being inactive, and the estimate of 75 per cent is derived by application of the least favorable correction for diagnostic error possible, based on the findings of this study.

Perhaps the greatest source of error in the interpretation of the survey roentgenogram is an insufficient appreciation of normal variation coupled with a determination not to overlook the very earliest lesion. It should be remembered that the normal pattern of lung markings varies to as great a degree as other physical characteristics and that some experience beyond that the opposite side but also usually in the upper half. Such lesions may progress and involve extensive areas. If they regress they may diminish in size until they disappear entirely (Fig. 5) but more commonly they leave small nodular or string-like scars (Fig. 2 and 3). Those who have observed this sequence frequently are in a position to express an opinion as to the stability of a given lesion from its appearance on the roentgenogram with a considerable degree of accuracy. This fact is of tremendous value in recognizing a residual or regressive stage which should be identified as such and closely observed but not subjected to immediate treatment or hospitalization.

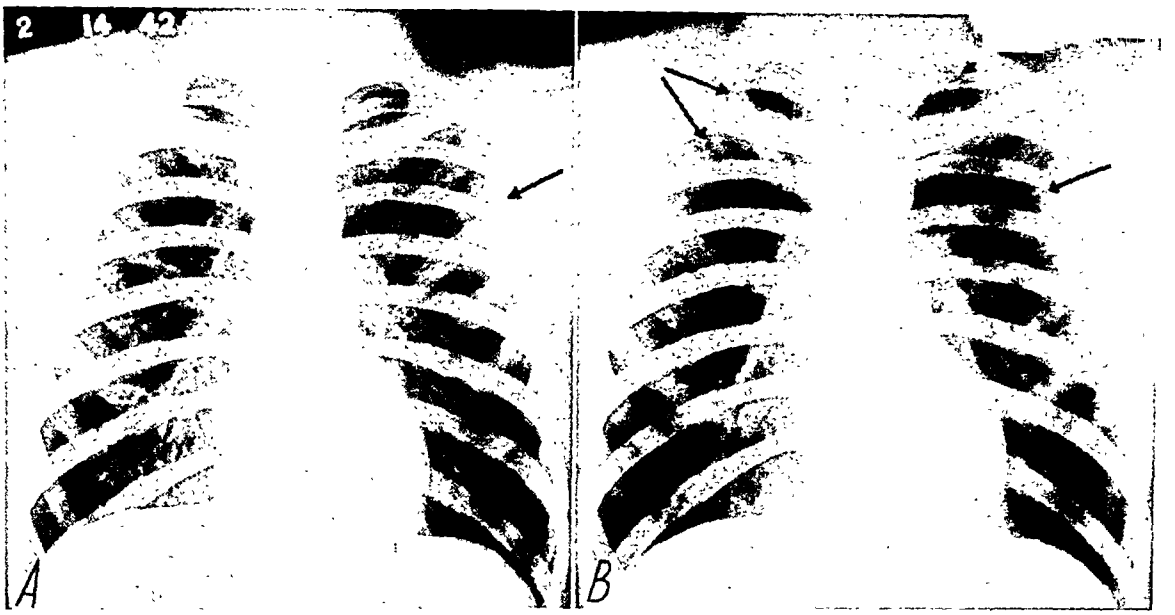


Fig. 4. *A*, fresh exudative lesion left infraclavicular area in white male, aged twenty-four. Refused hospitalization. *B*, extension to both apices.

PLAN OF STUDY

It was decided to study all cases of minimal tuberculosis reported by the Detroit Department of Health in the five year period 1940 to 1944 inclusive. Thus, by definition, the study would be confined to the small, non-cavitary lesions which must be evaluated purely from the quality of the roentgen findings. It was further felt that the two year follow-up period thus possible on even the most recent cases would be adequate to prove or disprove the accuracy of the initial reading. This assumption might seem to be open to question in view of some of the findings.

During this five year period 3,635 cases

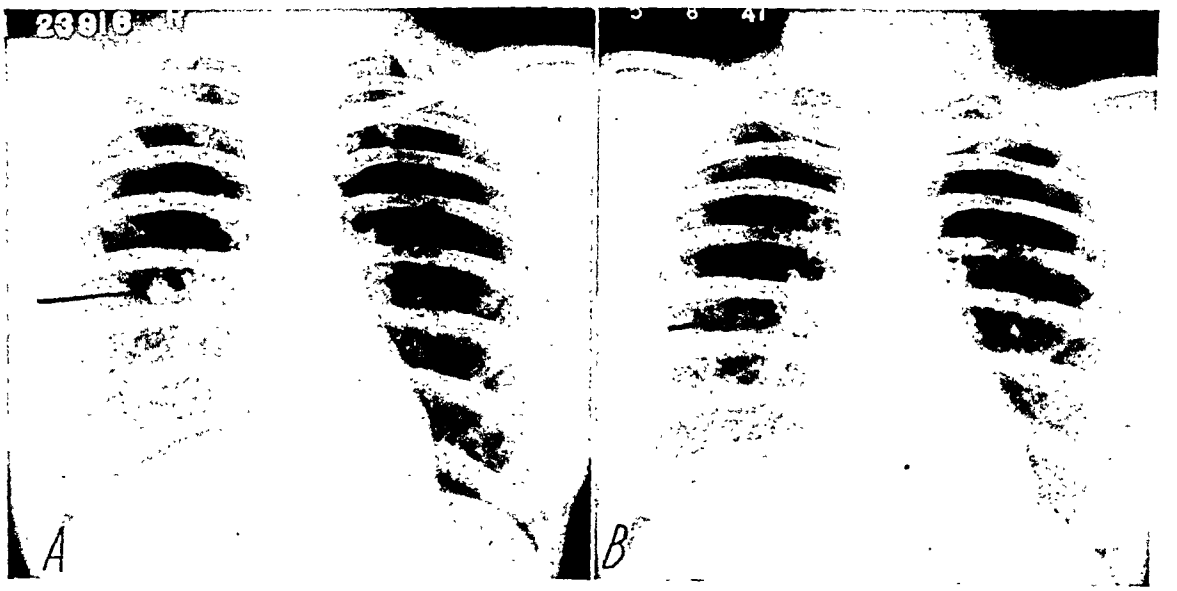


Fig. 5. *A*, white female, aged thirty-six, new lesion at right hilum in 1943. Sputum and gastric examination negative. Lesion has gradually regressed and would not now be visible without prior knowledge of its location and significance, *B*.

of minimal tuberculosis were reported by physicians, hospitals, and industrial concerns in the City of Detroit. Of these 2,557 were roentgenographed by the various units maintained by the Department of Health. However, from a study of the ratio of cases reported inactive to cases reported active for each year it is apparent that inactive minimal tuberculous lesions were not reported as scrupulously at the beginning of this period as in 1944.

	Active	Inactive
1940	119	149
1941	133	134
1942	186	242
1943	173	608
1944	156	657
Total	767	1,790

Only records of cases actually reported were available for study. *However, any previously unreported case which activated* before January 1, 1947, would be picked up as a prognostic error in our statistics. A two year observation period, or observation until activity was demonstrated, was obtained in only 765, one-third of the 2,557 cases initially examined by one of the Health Department units. The analysis of these 765 cases according to the initial interpretation "active," "inactive," or "questionably active" and the final results are shown in Table 1.

CRITERIA OF ACTIVITY

A lesion was considered to have demonstrated activity if there was evidence of any of the following during the period of observation:

1. *Change in the roentgen appearance of the lesion*, applying the dictum "a changing lesion is an active one." On this basis a clearing lesion is considered active, the only permissible exception being a gradual contraction, over a period of years, of a definitely fibroid process. Four of the "errors" (cases originally called inactive but later showing activity) had never been hospitalized and never had positive sputum reported but did show roentgen evidence of change.

2. *Positive sputum.* Two cases were listed as errors because of positive sputum or culture although no therapeutic measures other than bed rest were ever applied and there was never any change in the roentgen appearance of the lesion.

3. *Hospitalization*, unless the discharge note definitely stated that such observation definitely confirmed the original impression of inactivity.

4. *Therapeutic procedures*, other than bed

TABLE I

RESULTS OF TWO YEAR FOLLOW-UP OF 765 MINIMAL TUBERCULOUS LESIONS

	Reported Minimal Inactive			Reported Minimal Active			Reported Minimal Questionably Active		
Year	Number	Showed no Activity	Showed Activity	Number	Showed no Activity	Showed Activity	Number	Showed no Activity	Showed Activity
1940	55	43	12	21	2	19	4	1	3
1941	88	74	14	21	3	18	15	0	15
1942	99	90	9	29	4	25	16	2	14
1943	157	128	29	38	3	35	21	4	17
1944	173	154	19	18	1	17	10	1	9
Total	572	489	83	127	13	114	66	8	58
Active	14.5%			Active	89.75%		Active	88.0%	
Accuracy	88.5%			Accuracy	89.75%				

Total accuracy of interpretation, active and inactive 86.43%

rest alone, regardless of the indications since it would be impossible to prove that the eventual favorable outcome was not due to collapse measures. Three patients are carried as errors because they received ambulatory pneumothorax elsewhere. It was impossible to ascertain whether any of them had positive sputa or any other evidence of activity prior to collapse.

5. *Death of the patient*—unless evidence was available that tuberculosis played no part in the death. Any patient diagnosed as having tuberculosis in any stage who later develops some other illness and dies is likely to be reported as having died of some complication of tuberculosis. Figure 2 shows roentgenograms of a patient who entered the hospital in a moribund state with a presumptive diagnosis of tuberculous meningitis and died in a few days. This would have been carried as one of the errors had not an autopsy been obtained which established the diagnosis of lymphosarcoma. On the other hand, in those cases which died at home the cause of death had to be accepted as reported even though it might be some improbable combination such as "sunstroke and tuberculous meningitis" reported in one instance.

ANALYSIS OF RESULTS

Sixty-six cases were interpreted as being questionably active on the first examination. These were mostly lesions in which the character or quality of the infiltration did not justify a definite opinion as to stability. A few were of the type referred to as "coin lesions." They have been previously described[2] and when first seen must be regarded with suspicion (Fig. 5). A very few were listed in the questionable category simply because an opinion as to stability had been omitted through oversight or because only a small film (4 by 5 inch) or a technically imperfect film was available and opinion was deferred pending re-examination for which the patient failed to return. Of these 66 cases, 58 (88 per cent) eventually showed some evidence of activity.

Among the remaining 699 cases on whom definite opinions as to stability had been expressed the follow-up substantiated the original interpretation in 604, or 86.43 per cent. The apparently greater accuracy of

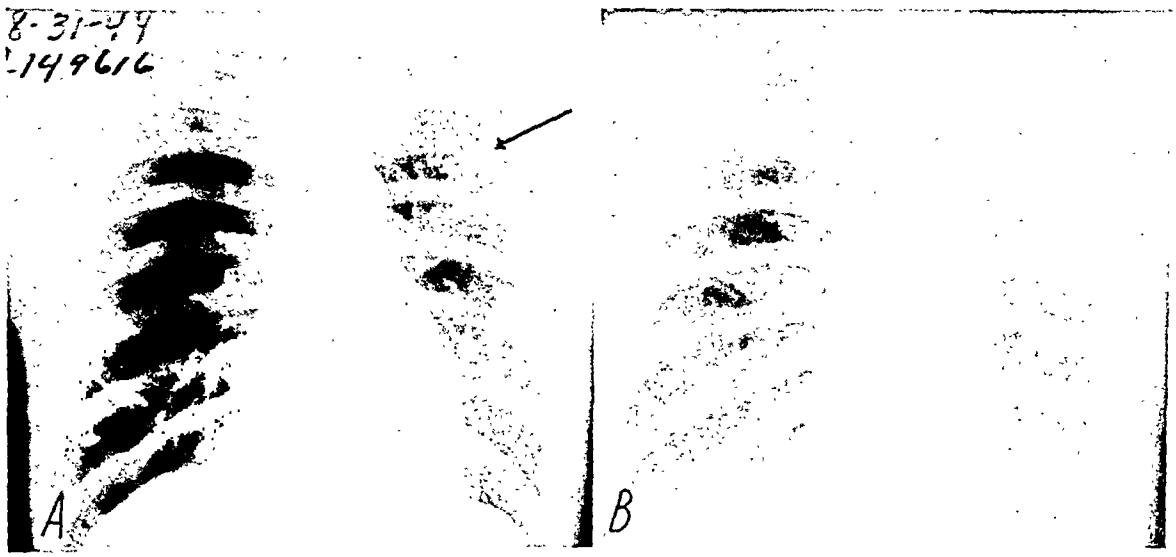


FIG. 6. *A*, photofluorogram of Filipino male, aged forty-one, read minimal inactive in 1944. Refused to return for re-examination. Consulted private physician in May, 1947, who referred him to one of our survey units. *B*, now has far-advanced tuberculosis.

TABLE II-A

Year	Number	Lost through Obsolete Address	Failed to Cooperate	Evidence of Activity	No Activity	Other
1940	27	9	17	—	—	1*
1941	38	23	14	—	1	—
1944	235	50	134	2	48	1†
Total	300	82	165	2	49	2
	Total recovered for re-examination				51	
	Recovered cases showing activity				2	
	Active 4%	Accuracy	96.0%			

* Died of cancer of throat.
† One case serving in Korea; probably inactive, but not included among inactives.

prediction of 89.75 per cent (114 proved active) among the 127 read active as opposed to 85.5 per cent (489 remaining inactive) among those 572 read inactive is partly due to the greater tendency for return of the active cases. When these break down and become symptomatic they tend to be referred back by their physicians or to return of their own accord (Fig. 6) or when incidental roentgen examination elsewhere discloses extension of the pulmonary process this information is reported to us and the case then appears as an "error" on these statistics. On the other hand, the individual whose first few check-up roentgenograms show no extension often considers it too troublesome to continue his return visits and is therefore lost to us. If all such cases could be re-examined regularly the degree of accuracy would, in our opinion, be significantly improved in the group read inactive on first examination. Conversely, the percentage of error might be greater in the group originally called active.

TABLE II-B

EFFECT OF SPECIAL FOLLOW-UP STUDY ON PERCENTAGE OF ACCURACY

	Number	Accuracy
1. 1944 inactive group		
(a) original	123	85.4%
(b) final	173	89.1%
2. Total 5 year group		
(a) original	714	85.4%
(b) final	765	86.4%

Some indication of the results obtainable with better control of the patient is shown by a study of 1,592 employees called inactive tuberculosis from roentgenographic findings and approved for work with a large industrial corporation during the years 1942–1946.[5] These cases were available for re-examination at intervals as designated by the roentgenologist. The incidence of activation was 1.38 per cent which implies a prognostic accuracy of 98.62 per cent.

From an administrative point of view it was impossible to recall all of our 1,791 cases on whom a two year study was not obtained. However, a sample of 300 cases initially interpreted as "minimal inactive" was selected (on no other basis than that their period of observation had been less than one year) and an effort was made by letter to persuade these people to return for another roentgen examination. It was hoped that one-third (100 cases) might respond and the results might, by inference, shed some light on what happens to lost cases. However, the response, as indicated in Table II-A, was disappointing. Of 65 cases first examined in 1940 and 1941, 32 were lost because of obsolete addresses as indicated by unclaimed letters. Thirty-one apparently received letters but did not cooperate. One had died of carcinoma of the larynx and only one came in for a roentgen examination, which showed that the lesion had not changed. Of 235 letters sent to

patients first examined in 1944, 50 were returned because of obsolete addresses. One hundred thirty-four patients received letters but did not cooperate. Fifty returned for roentgen examinations. Of these, 48 showed no change at the time of re-examination and 2 showed evidence of activity. Poor as this response was, it sufficed to change the percentage of accuracy for 1944 alone from 85.4 per cent to 89.1 per cent, although the percentage of accuracy of prediction for the entire five year inactive group is not altered significantly, the change being only 1.03 per cent (85.4 per cent to 86.43 per cent. Table II-B). If one were permitted to project the findings in this small series of recalled cases for the entire group of 1,791 lost cases, a final over-all prognostic accuracy of 90 per cent or better might be anticipated.

It might be well at this point to anticipate the objection that the results obtained could in part be due to overreading insignificant lesions among which the breakdown rate would naturally be low. Without exhibiting all 572 cases read inactive this is difficult to refute since it is known that the correlation of opinions of different interpreters reading the same films is not absolute.[1] For this reason, we analyzed all cases referred to the clinic in 1944 with roentgen diagnoses of minimal tuberculosis made elsewhere. Our interpretations of roentgenograms on these patients were as follows:

Our Interpretation	Number	Per Cent
Minimal	5	4.2
Minimal inactive	62	52.1
Fibrosis Calcium deposits No evidence of tuberculosis	52	43.7
	119	100

As indicated, 43.7 per cent of these 119 cases had been interpreted in this Department as showing no evidence of tuberculosis. This would seem to indicate that the results obtained are not due to overreading.

ERRORS IN DETERMINING ACTIVITY

It was hoped that from the standpoint of improving future accuracy an analysis of the 83 "mistakes" among the cases originally called inactive might yield useful information and a better understanding of the roentgen-ray quality of an unstable lesion. This was not the case. In 4 instances it was felt that the initial reading had been

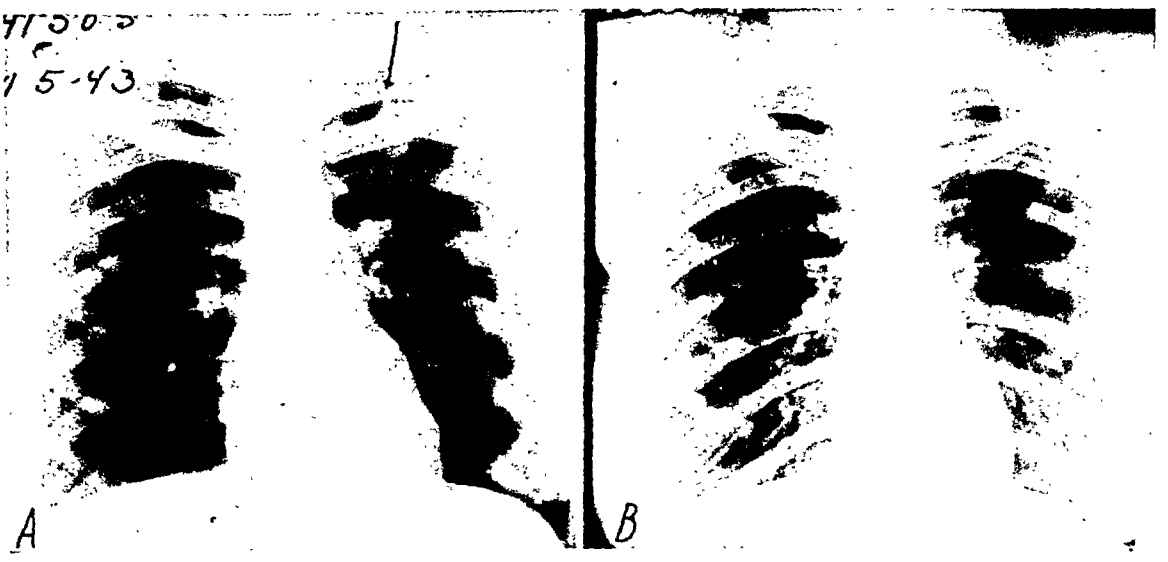


FIG. 7. *A*, colored female, aged eighteen, in 1943. Showed only gradual contraction of process for two years. *B*, at time of delivery in 1945. Early re-examination advised at this time but patient failed to return. Died elsewhere of far-advanced pulmonary tuberculosis.

incautious. In 2 more it was felt that error resulted from attempting to determine activity from the small (4 by 5 inch) film (Fig. 6). Despite reports to the contrary[1] we do not believe that the 4 by 5 inch film is as reliable as the 14 by 17 inch, and, although at times forced to interpret activity from the photofluorogram because of film shortages during and after the war, we believe its use should normally be confined to screening. A diagnosis should be made only from the 14 by 17 inch film.

In the remaining 77 cases it was felt that without knowing the final outcome, the initial roentgenogram would still be read as "inactive." Of these, 4 spread coincident with pregnancy; 2 in less than a year, 1 after one year, 1 after two years (Fig. 7). Another spread following tracheotomy for carcinoma of the larynx. On many records the statement appeared that the patient was an alcoholic, or uncooperative. However, the difficulty in getting follow-up roentgenograms on all of these patients indicates that lack of cooperation is not characteristic of the "breakdown" group alone.

The analysis of the "errors" according to the period of apparent inactivity and present status is summarized below:

Group I Less than 1 year inactivity			48	57.8%
A. Hospitalized at once		8		
B. No follow-up films prior to "breakdown"		18		
C. Activity evident on 1st routine check-up x-ray		13		
D. Less than 1 year inactivity on routine check-ups		9		
Total Group I		48		
Group II Less than 2 years but more than 1 year			15	18.1%
Group III Less than 3 years but more than 2 years			12	14.5%
Group IV Less than 4 years but more than 3 years			7	8.4%
Group V One 5 years			1	1.2%
Total			83	100 %
Less than 2 years	63	76%		
More than 2 years	20	24%		
Total	83	100%		

Eight cases were hospitalized at once despite a roentgen interpretation of inactive pulmonary tuberculosis. This is properly an important part of the program. If there is evidence of hemoptysis, tracheobronchial disease, or extrapulmonary tuberculosis, the clinician will hospitalize the patient regardless of the roentgen interpretation. Eighteen cases had no follow-up roentgenograms between the initial reading and the time activity was demonstrable. In 1 case there was a five year lapse following the first roentgenogram; when the patient did return his disease was far advanced. Such cases were considered to have no proved period of stability. Thirteen cases showed change on the first routine re-examination and therefore had no proved periods of stability. In 9 cases routine check-ups showed no change for periods of several months but less than one year. These four categories, totaling 48 cases (57.8 per cent) comprise Group 1, those with less than one year of apparent stability. Group II includes 15 cases (18.1 per cent) with more than twelve months but less than two years of apparent inactivity as demonstrated by periodic re-examination. Group III, 12 cases (14.5 per cent) two or more years' stability. Group IV, 7 cases (8.4 per cent) three or more years. One case (1 per cent) was followed five years before there was roentgen evidence of activity. Thus it is seen that 20 cases (24 per cent) of the "errors" broke down some time after the second year of observation which again raises the point, alluded to in the beginning of this paper, that a lesion

which has demonstrated apparent inactivity for two or more years is not necessarily a "safe" lesion and that roentgen follow-up at regular intervals must be continued for an indefinite period.

It would be fruitless to speculate here on the question of reinfection versus reactivation. In only one of these cases did the "spread" definitely appear to involve a new lung area while the original lesion remained unchanged. It should be unnecessary to point out that it is not in any sense implied that a lesion is "sterile" when it is called "inactive."

The present status of cases showing activity originally read inactive can be summarized as follows:

Deaths	18
Hospitalized at present	16
Apparently arrested	36
Status not known	13
Total	83

The 18 deaths were all assumed to be due to tuberculosis. This includes the case which spread following tracheotomy for laryngeal carcinoma. According to available information, 16 patients are in sanatoriums at the present time. Thirty-six cases are apparently arrested. The present status of 13 cases cannot be determined. These are individuals who left the city or otherwise concealed their whereabouts after leaving the hospital against advice or upon being informed that their disease had become active.

An analysis as to age, race, and sex of the 83 errors compared with proved inactives, as well as the entire 11,062 cases of adult or reinfection type tuberculosis of all stages reported for this same-five-year period from the City of Detroit, was attempted.

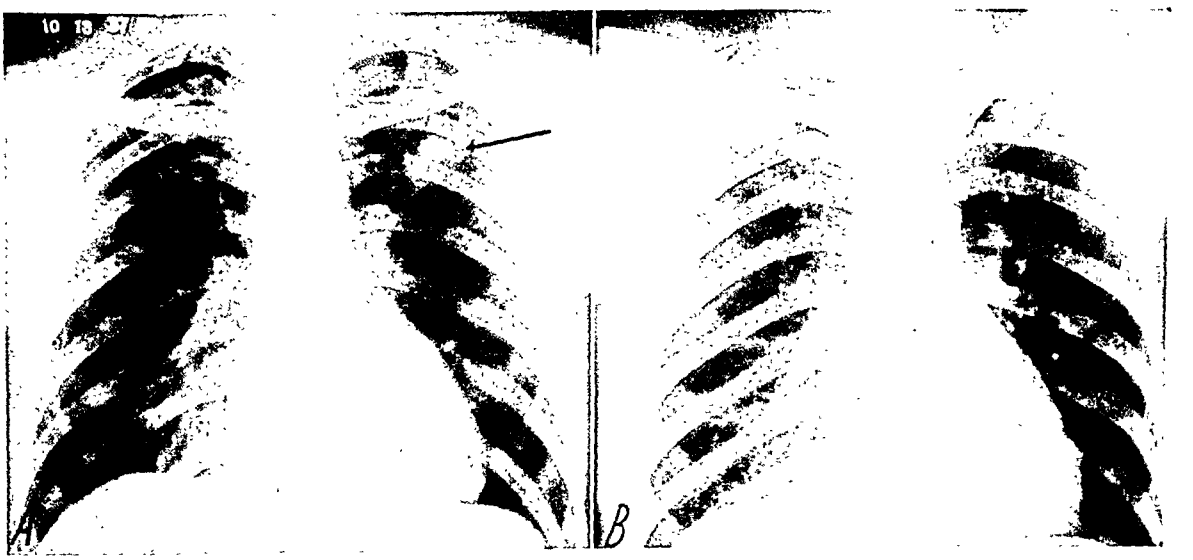


FIG. 8. *A*, white male, aged thirty-three, with history of exposure and positive tuberculin test. No symptoms. Read active minimal tuberculosis. *B*, complete clearing in two weeks.

The error group is too small to be of great statistical significance, but it would appear that the younger patient is more likely to have an unstable lesion. This is to be expected as the younger patient has the more recent infection. An anticipated higher degree of stability of minimal tuberculous lesions among white persons as compared to non-white persons could not be demonstrated. This is perhaps due to the small number of cases.

ERRORS IN DIFFERENTIAL DIAGNOSIS

One case interpreted originally as minimal inactive tuberculosis proved eventually to be primary carcinoma of the lung. It

must be pointed out that in this case, a colored male, aged twenty-eight, the disposition would have been the same on the basis of tuberculin test, which was positive, sputum studies, and gastric aspirations. Some confusion resulted from a false positive sputum report. The lesion was still inaccessible to the bronchoscope when its true nature was first suspected. A correct diagnosis could only have been made by examining bronchial secretions for malignant cells, a method not then widely used. Thoracotomy was done, but the lesion was not resectable.

One would anticipate that the pneumonias, particularly of the virus or atypical variety, would be the greatest source of error in the differential diagnosis. Although this error has occurred and will no doubt continue to occur in this clinic (Fig. 8) there were no examples in this particular series due to the method of selecting material; only reported cases of minimal tuberculosis were included in the study. When the possibility of confusing tuberculosis and pneumonia exists, the reporting is delayed until the diagnosis can be clarified. It is the policy of this Department to recommend re-examination in four weeks when a pneumonia is suspected whereas re-examinations are requested at three month intervals if the initial diagnosis is inactive minimal tuberculosis.

CONCLUSIONS

1. As a result of mass surveys increasing numbers of minimal tuberculous lesions are being discovered. More than 75 per cent of these have acquired stability at the time they are found.

2. It is important, particularly in large metropolitan areas, that a rapid and accurate estimate of activity be made to permit a concentration of effort on the active case and avoid dissipation of facilities on the inactive case.

3. Activity can be determined accurately by roentgen examination and more rapidly and economically than by bacteriologic methods. In a group of 699 cases of minimal tuberculosis followed for two to five years, activity was correctly determined from the first roentgenogram in 86.43 per cent.

4. Success in such a program depends on the services of an experienced roentgenologist and the use of the large film.

5. The photofluorogram should be used for screening only.

6. Patients with minimal inactive pulmonary tuberculosis should be followed by roentgen examinations at three month intervals for two years from the time of discovery and at longer intervals for an indefinite period thereafter.

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TUBERCULOSIS OF THE STOMACH AND DUODENUM*

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GASTRIC and duodenal tuberculosis are uncommon lesions. Proof, following operation or autopsy on a patient who was considered to have benign ulcer or carcinoma, usually causes considerable surprise to the physician. There are certain suggestive findings in the roentgen examination which, while not conclusive, may lead to the correct preoperative or antemortem diagnosis. These we intend to discuss.

INCIDENCE

The largest series was reported by Good[10] in 1931. He found the average incidence of gastric tuberculosis in autopsies and gastric resections from the Mayo Clinic and other published figures to be 0.34 per cent. If only the cases with other tuberculosis were considered, the incidence rose to 1.4 per cent. Other series have shown a much lower incidence: Hardt and Cohen[12] found 1 case in 1,000 autopsies of tuberculous patients. Windwer[26] reported 1 case in 21,000 hospital admissions. There were 3 cases in Cook County Hospital from 1929 to 1938 (Sullivan *et al.*[21]). There has been a total of 10 cases at the Mayo Clinic up to 1943 (White[24]).

Duodenal tuberculosis is much rarer. Migliaccio[15] states that there are only 12 proved cases limited to the duodenum and regional lymph nodes up to 1946. However, about 10 per cent of gastric tuberculosis has associated duodenal involvement, and when the pylorus is involved the incidence of duodenal lesions is very high (Ricard and Chevrier[20]).

At the Philadelphia General Hospital there have been 2 cases of gastric and 1 case of duodenal tuberculosis since 1936.

PATHOGENESIS

Many authors (Broders,[3] Renander,[19] White[24]) have discussed the probable routes of infection. The possibilities are: (1) direct infection through the mucosa; (2) through the blood stream; (3) by lymphatic channels; (4) spread by continuity from adjacent structures, especially the lymph nodes. There is no reason to suspect that all may not operate at different times, but in a number of cases the involvement of adjacent mesenteric nodes seemed the primary lesion. This will be discussed later.

The reason for the rarity of gastric and duodenal tuberculosis when the disease is so common to the rest of the gastrointestinal tract is obscure. Suggested elements have been: (1) the gastric acidity; (2) presence of an intact mucosa; (3) scarcity of lymphoid structures in the gastric wall; (4) the rapid emptying time of the stomach; (5) inherent resistance. None of these have been proved.

TYPE OF LESIONS

Gastric. The commonest lesion, which occurs in about 80 per cent of cases (Broders[3]), is the ulcer. This may be single or multiple, large or small, and usually occurs on the lesser curvature side between the incisura and the pylorus. The other major type is the proliferative or hypertrophic, in which there is invasion of the gastric wall and very often tumor formation. The tumor frequently causes an annular constricting lesion very much like carcinoma (Broders,[3] Good,[10] Browne[4]). There is often a combination of ulcer and tumor or ulcer and infiltration. Other types which are less important are solitary or miliary tubercles, larger nodular foci, and diffuse tuberculous gastritis. All usually have extensive lymph node involvement which may dominate the picture (Ackermann[1]).

Duodenal. The hypertrophic type particularly may extend through the pylorus and involve the duodenum (Matthews,[14] Cames[5]). Single or multiple ulcers are

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found in the duodenum which often lead to considerable deformity (Reeves[17]). The second and third portions are involved much more frequently than in the usual peptic ulcer (Cames,[5] Grossman,[11] Migliaccio[15]). Perforation, sinus tracts and fistulae may occur (Psenner,[16] Wichtl,[25] Beresford-Jones[2]).

Associated Lesions. The commonest associated lesion is tuberculosis elsewhere in the body. Isolated gastric and duodenal tuberculosis, however, does occur. Good[10] states that at operation tuberculosis of the stomach is met with just as frequently in subjects in whom no other tuberculosis can be demonstrated. About 10 per cent of the cases in the literature have associated gastric carcinoma (White[24]). Enlarged mesenteric and retroperitoneal tuberculous lymph nodes are a prominent finding in almost all recorded cases.

ROENTGENOLOGIC FINDINGS

Most authors have found nothing characteristic in the ulcerations or hypertrophic lesions demonstrated roentgenologically. The appearance is that of carcinoma or benign ulcer and, in the case of pyloric lesions, the preoperative diagnosis usually has been carcinoma or syphilis. Renander[18,19] calls attention to a hypertrophic polypoid appearance of the involved mucosa. In one of his cases he found an hour-glass constriction of the pars media which was felt to be more rounded and cuff-like than the usual appearance. He also notes a relative lack of interference with peristalsis in what appears to be an extensive carcinoma. Ackermann[1] noticed this finding and also demonstrated a sinus tract extending from the duodenal cap. He points out that involvement of the duodenum as well as the stomach is a suggestive diagostic point.

CLINICAL ASPECTS

The symptoms are not characteristic. There is usually pain after meals, loss of weight and strength, and vomiting (Good,[10] Walters,[22] *et al.*). Fifty per cent have a palpable mass (Walters[22]). The treatment is radical surgical resection. Prognosis is good when the lesion is isolated and otherwise depends on the extent of tuberculosis elsewhere (Good[10]).

REPORT OF CASES

CASE 1. M. McG. The patient was a white woman, aged forty-five, born in Ireland. She was first admitted to the hospital on the service of Dr. T. Klein, September 7, 1943, complaining of enlargement and breakdown of nodes. The onset of her disease had been five or six years before with enlargement of the cervical lymph nodes. Some of these opened spontaneously and others were incised by her physician, resulting in a number of draining sinuses. Several years later other nodes in the axilla, breast and inguinal region appeared, as well as nodules in the soft tissues of her arms. There were occasional bouts of chills and fever, some anorexia and weight loss.

On physical examination she was emaciated and showed generalized adenopathy. There were scars in the submaxillary region from previous sinuses. Multiple masses were palpated in the abdomen and nodules were present in both upper arms. Biopsy of an axillary lymph node was reported as showing a large area of caseation surrounded by epithelioid and giant cells and many small tubercles. The diagnosis was tuberculosis of lymph node (Dr. W. E. Ehrich). Roentgen examination showed the chest to be essentially normal except for some moderate elevation of the right diaphragm. There was no evidence of calcification or abnormal masses in the abdomen.

The patient was discharged from the hospital on September 16, 1943. As an out-patient she received roentgen therapy to the cervical, axillary and inguinal regions On February 9, 1944, she was readmitted because of chills and fever, night sweats and loss of weight. For the last two months she had had nausea but no vomiting. Gastrointestinal roentgen examination on February 18 (Fig. 1, 2 and 3) showed a large ulcer on the lesser curvature of the pars media with some induration of the adjacent gastric wall. No peristalsis passed through the region of the pyloric antrum, which appeared rigid and infiltrated. There was marked alteration in the normal mucosal markings in the antrum as well as in the pars media. The pylorus was eccentric and there was 40 per cent gastric retention in twenty-four hours. No

abnormality was noted in the duodenum. Roentgen examination of the chest was essentially normal.

The patient developed epigastric pain which became worse in spite of a Sippy regimen. Sputum smears and cultures for the tubercle bacillus were negative on numerous occasions. Gastric washings were also negative. The blood Wassermann and Kline reactions were negative. The blood showed a mild anemia and leukocytosis. Gastric analysis revealed free acid of 39 per cent and a total of 53 per cent, with a faint trace of blood. On April 19 laparotomy was performed by the service of Dr. W. E. Burnett. There was heavy infiltration serosally extending upward to the cardia from the lower third of the lesser curvature Around the stomach and in the mesentery there were many lymph nodes suggestive of widespread tuberculosis adenitis. The stomach was opened and two ulcers resembling benign peptic ulcers were seen. The stomach was then closed and resected, which was difficult because of many adhesions A perforation pocket with abscess formation was opened on the lesser curvature and 3 to 5 cc. of contents removed.

Pathological Report. Gross description by Dr. E. Mertens: "The specimen is the lower 13 cm. of the stomach. The serosal surface shows a sinus opening near the pyloric end. There are adhesions about this, and a thickened, indurated area which occurs at the upper extremity of the specimen. Several nodes are included. The largest measures 1.4 cm. and shows caseation on section. The mucosal surface shows a soft cobblestone roughening everywhere. There are multiple ulcers, some shallow and hemorrhagic and others shallow and necrotic. There is one with a crater measuring 1.5 by 1.0 cm. on the lesser curvature at the upper end of the specimen. Another, with a much hypertrophied edge showing extensive undermining, leads to the sinus opening near the pyloric end. There is also a small opening on the lesser curvature at the upper end, leading to the excision line. Impression: Gastric tuberculosis with multiple ulcers and fistula."

Microscopic examination by Dr. W. E. Ehrich: "Several sections through ulcers, fistulous tracts and lymph nodes all show the characteristic picture of tuberculosis with epithelioid cells, Langhans' giant cells and caseation necrosis. There is nothing to suggest malignancy here. *Pathological diagnosis:* Tuberculosis of stomach."



Fig. 1. Case 1. Gastric tuberculosis. Large, penetrating ulcer on lesser curvature of pars media, with surrounding infiltration of gastric wall. There is gastric dilatation from partial obstruction at the outlet, due to the associated involvement of the pyloric region.

The patient did well following operation and was discharged on May 29. On August 7, 1944, she was readmitted in extremis with a history of vomiting, abdominal pain, swelling of the abdomen, loss of weight and diarrhea. She died two days later. Only a limited autopsy was done. Extensive miliary tuberculosis of the abdominal organs with tuberculous peritonitis was found. There was no gross evidence of pulmonary tuberculosis.

Case II. I. H. The patient was a colored male, aged twenty-five, who was admitted to the service of Dr. D. Spotts on October 21, 1945 with a chief complaint of hematemesis. His history went back to 1943 when he had an acute attack of vomiting and low abdominal pain of short duration. In 1944 there was vague abdominal pain followed by occasional vomiting. The pain, at first only at night, later appeared following meals, and for the last week he had vomited blood on several occasions. He now had sharp pain in the abdomen radiating toward the chest. There was a 20 lb. weight

loss during the last three months. Physical examination revealed adbominal distention with tenderness on the right side and some enlarged inguinal lymph nodes. Initially there was a mild anemia which became more severe during the period of hospitalization. Gastric analysis disclosed a free acid of 32 per cent and a total of 81 per cent. The blood Kline reaction was negative.

Roentgen examination on November 9, 1945 (Fig. 4), showed a dilated, atonic stomach with obstruction at the pylorus or the first portion of the duodenum. The duodenum was not well visualized during the examination. Lung fields were normal.

Laparotomy was performed on November 20, 1945, by Dr. P. A. McCarthy. A dilated and very large stomach was found. There was a large duodenal ulcer with massive surrounding adhesions. Gastric resection at the upper third with gastroenterostomy was done. The surgical diagnosis was duodenal ulcer.

Postoperatively the patient did not do well and a fistula developed in the wound. A sub-

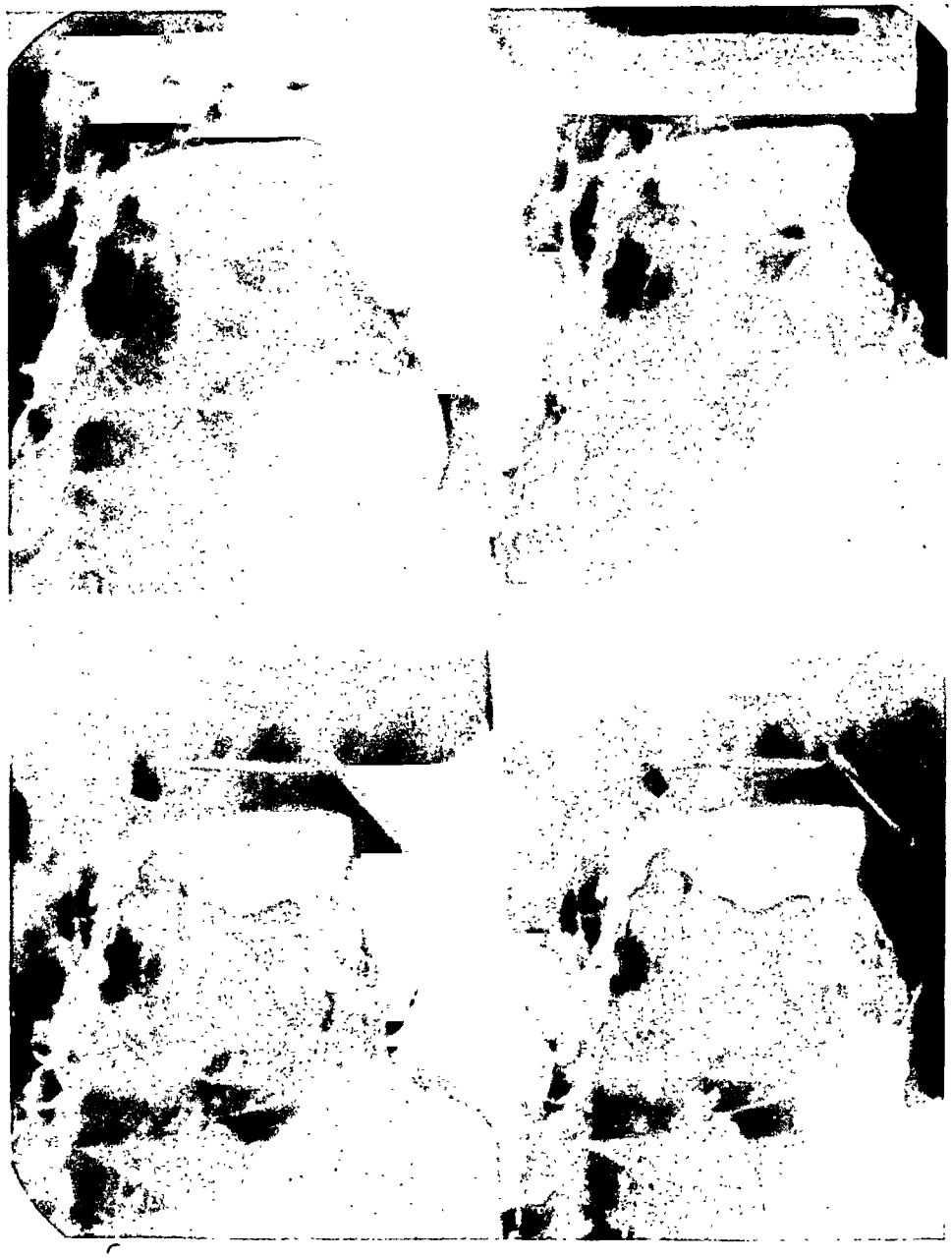


FIG. 2. Case 1. Gastric tuberculosis. Deformity and rigidity of prepyloric region. Loss of normal mucosal folds.

diaphragmatic abscess was suspected clinically and by roentgen examination. There was spiking fever and the patient weakened progressively and died on January 12, 1946.

Autopsy by Dr. A. Valdes-Dapena: "*Gross examination:* Practically all the nodes of the peritoneal cavity are enlarged. The largest measures 2 to 3 cm. in diameter. The nodes around the hilum of the liver are matted together and adhere to the surrounding structures especially to the duodenum. Masses of nodes surround the common bile duct and the pancreas. The duodenum is surrounded by matted lymph nodes and adhesions. The mucosa shows a peculiar appearance: it is studded with light gray nodules about 2 mm. in diameter; these are soft and some of them can be squeezed out, yielding a light yellow paste. This condition prevails from the proximal stump for at least 10 cm. down the duodenum. There are several small ulcers, some of them appearing to communicate with the suprahepatic space. The liver is located in the midst of adhesions. To the left there is a cavity limited on one side by the liver and on the other by the diaphragm. This cavity contains what seem to be food material

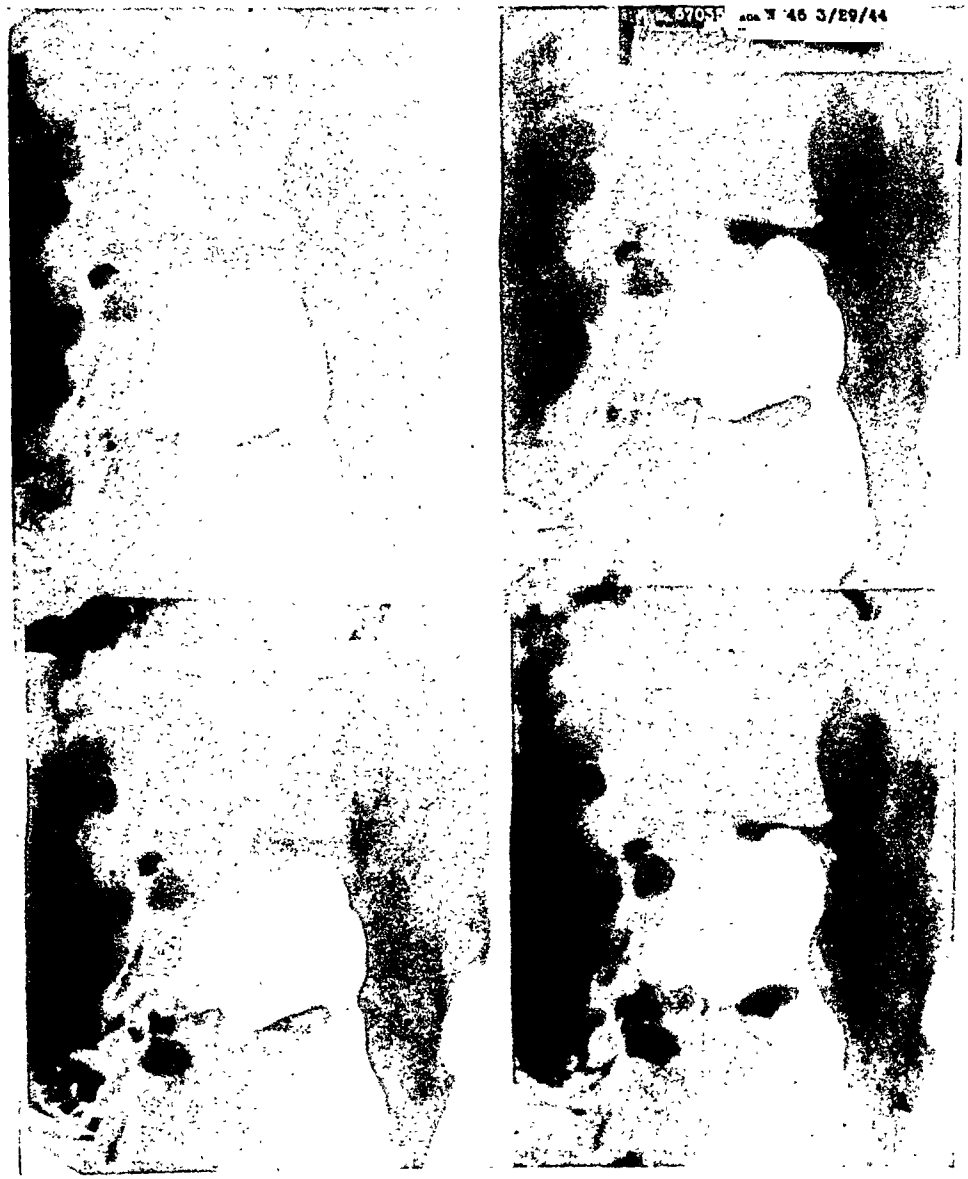


Fig. 3. Case 1. Gastric tuberculosis. Further deformity of prepyloric region, six weeks after Figure 2. The pylorus is eccentric. The lesser curvature ulcer is also seen.

and a yellowish paste. The cavity communicates through a long tract with a small opening in the upper part of the wound. It also appears to have communicated with one of the small ulcers in the duodenal stump.

"*Microscopic examination:* Sections taken from the abdominal lymph nodes show caseation necrosis due to tuberculosis. There is tuberculous infiltration of the duodenum. Lungs: marked passive congestion; acute parenchymatous degeneration.

"*Final diagnosis:* Tuberculosis of abdominal lymph nodes and duodenum with perforation."



FIG. 4. Case II. Duodenal tuberculosis. Grossly dilated stomach, the result of obstruction in the duodenum.

CASE III. S. A. The patient was a colored male, aged forty-three, admitted to Philadelphia General Hospital August 13, 1943, on the service of Dr. C. Brown. The patient had had loss of weight and occasional abdominal pain since early in the year. At the out-patient department of another hospital, a gastrointestinal series and gastric analysis were negative and the only abdominal finding was hepatomegaly. Since May there had been vomiting and loss of weight and strength. On admission he was emaciated and the liver and spleen were much enlarged. Laboratory studies showed the gastric free acid to be 49 per cent and total acid 98 per cent. There was a positive reaction for occult blood. The red blood cell count was 3,000,000 with anisocytosis, poikilocytosis, and macrocytosis. The white blood cells were not increased. The blood Kline reaction was positive. Sputum was negative for tubercle bacilli. A roentgenogram of the chest on August 26, 1943 was negative except for elevation of the right diaphragm, and film of the abdomen showed an enlarged liver with some distention of the bowels and thickening of the segments. The patient was treated conservatively and was improving slowly when he died suddenly on September 16, 1943.

Autopsy by Dr. D. R. Coman: "*Gross examination:* The esophagus is negative. The stomach contains 1,500 cc. of fresh blood. There is a large peptic ulcer on the lesser curvature midway between the esophagus and pylorus, measuring 5 cm.; its base presents a gaping artery. Two and a half centimeters above this ulcer there is another ulcer with a dirty, granular base, and from it a fistulous tract leads through masses of fibrous tissue to an abscess

in the lesser peritoneal cavity. A part of the fistula runs beneath the peptic ulcer. Near the latter are two smaller ulcers. The small intestine, especially the jejunum and ileum, presents large, thick, granular patches; the serosal surfaces over these lesions are studded with tiny tubercles.

"The liver and spleen are enlarged and show many caseous nodules. Mesenteric, peripancreatic and perigastric nodes are enlarged to three or four times normal size, and on section reveal caseation necrosis. The lungs show only a calcified nodule 2 to 3 mm. in diameter and one calcified mediastinal node. There is also some calcification and fibrosis in the pleura on the right.

"*Gross diagnosis:* Tuberculous ulcer with fistula of the stomach. Peptic ulcer with eroded artery. Tuberculous abscess, lesser peritoneal cavity. Hyperplastic tuberculosis of the small intestine. Caseous tuberculosis of the liver and spleen. Healed primary tuberculosis of the lung.

"*Microscopic examination:* There is caseous tuberculosis of the liver and spleen. The stomach shows caseous tuberculous gastritis with ulceration."

DISCUSSION

Pathologically the chief characteristic of all 3 patients was the presence of multiple ulcerations and fistulous tracts. A perforation pocket with abscess formation was present on the lesser gastric curvature in Case I, as well as a sinus near the pylorus. In Case II there was a perforation of the duodenum and a tract leading to a subdiaphragmatic abscess. Case III had a tract from a gastric ulcer to an abscess in the lesser peritoneal cavity. Although we did not demonstrate these tracts roentgenographically, similar findings have been shown before (Psenner,[16] Wichtl,[25] Ackermann[1]). If such sinuses or fistulae can be demonstrated, a tuberculous etiology should be strongly suspected.

Other roentgenologically suggestive findings are simultaneous involvement of both the stomach and duodenum by the disease, which was not present in our cases. In Case I the large lesser curvature ulcer, extensive mucosal changes and infiltration of the pylorus might have suggested tuberculosis, but a malignant condition could produce the same appearance. Gastric tuberculosis was suspected in this woman because of the known tuberculosis of lymph nodes. Case II showed nothing roentgenographically except obstruction at the outlet of the stomach; the duodenal perforation probably occurred at a later date.

The extensive involvement of the surrounding lymph nodes in all cases is interesting. The lymphatic disease may even be the primary lesion. Certainly in Case I the patient had recognized tuberculosis of lymph nodes for years before the development of gastric symptoms. A similar case, reported from the Massachusetts General Hospital,[6] also had peripheral tuberculous adenopathy for years before development of duodenal tuberculosis with subsequent perforation. There had been no evidence of ulceration or mucosal changes in the duodenum two months before death, but there was deformity of the third portion due to pressure of an extrinsic mass, evidently a lymph node. In our Case II also it was the pathologist's opinion that the duodenal infiltration was secondary to the lymph node disease.

None of our patients had evidence of active pulmonary tuberculosis, and at autopsy only a calcified primary complex was found in one of them. The absence of a pulmonary lesion should not be considered evidence against gastroduodenal tuberculosis.

SUMMARY

1. Two cases of tuberculosis of the stomach and one of the duodenum are described. In all three cases the lungs showed no active pulmonary tuberculosis. One patient had had peripheral tuberculous adenitis for years, and in all three cases abdominal lymph node involvement was a very prominent feature. All three patients developed perforations or fistulous tracts at the site of their lesions.

2. From the roentgenologic standpoint there are no pathognomonic findings. The ulcerative and infiltrative lesions can

easily be confused with benign ulcer or carcinoma. A combination of both types of lesions, as well as extensive mucosal nodularity, as in one of our cases, might be suggestive. The most significant findings that can be demonstrated roentgenographically are simultaneous involvement of the stomach and duodenum, the presence of fistulae or sinuses, and signs of external pressure by enlarged lymph nodes. These should make the examiner strongly consider the likelihood of tuberculosis, even in the absence of any pulmonary lesion.

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TUMORS OF THE UPPER THIRD OF THE STOMACH*

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WHEN speaking of the upper third of the stomach we understand it to be the fundus proper, the cardia and the portion situated immediately beneath it. We include also in this paper tumors of the abdominal esophagus, believing it is justified by the frequency of invasion observed in both parts, whichever one may be the primary site of the growth. Very rarely are the tumors discovered when they are confined to their initial location. The tumors that make up this group require special mention, as the anatomic conditions peculiar to the region give them unique features and explain in certain measure how they can be more easily overlooked than tumors of the middle and lower thirds.

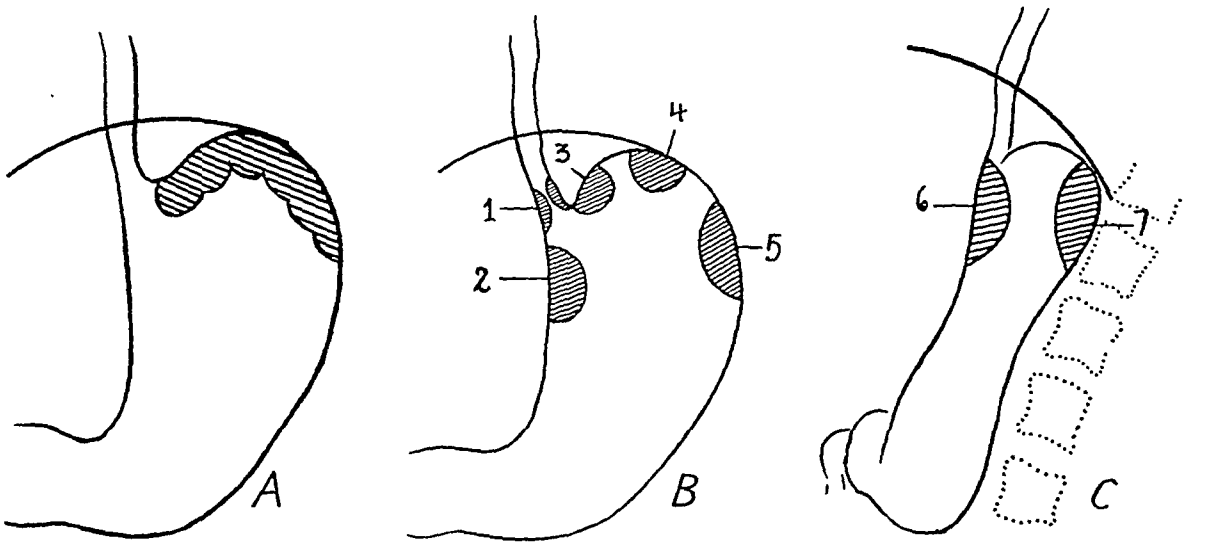


FIG. 1. Different locations of tumors of the upper third of the stomach. *A*, massive, *B*, *1*, tumor of the cardia; *2*, tumor of the lesser curvature immediately beneath the cardia; *3*, tumor of the medial margin above the cardia; *4*, tumor of the superior margin; *5*, tumor of the lateral margin; *C*, *6*, tumor of the anterior surface; *7*, tumor of the posterior surface.

The upper third of the stomach is situated deep in the left hypochondrium and is inaccessible to palpation under the screen. Another difficulty encountered in the diagnosis of lesions located here is the fact that the opaque substance, when the examination is made in the vertical position, passes rapidly through this part without stopping, and in the routine examinations in the Trendelenburg position the abundant quantity of barium that spreads hides them unless they are marginal or have reached considerable size. Apart from this, the growths at this level are not so frequent and the roentgenologist has a tendency to examine this area less carefully than the other regions.

The circumstance that favors the discovery of tumors of this part is the existence of the air bubble of the stomach. In its space the tumor is projected as a soft tissue shadow that alters its outline. When the air bubble does not exist or its shape and size are unusual, the radiologist can exaggerate it by injecting gas. This can be done by the method he prefers (giving mixtures that produce gas or by indirect insufflation through a tube).

Notwithstanding their great value, the

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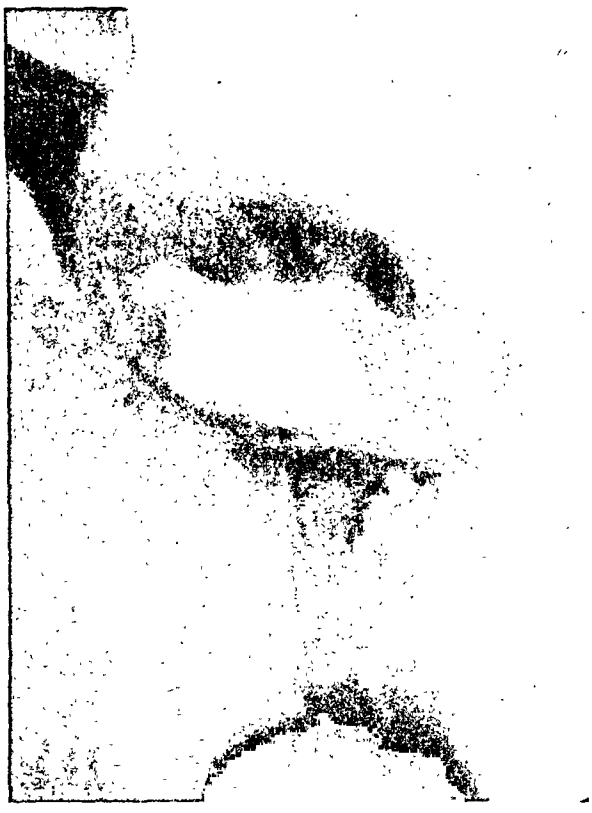


FIG. 2. Tumor that invades the fornix in massive form. The masses show against the air bubble as shadows of soft part density. (Confirmed by surgery.)



FIG. 3. Stricture of the abdominal esophagus through infiltration. The tumor mass is visible at the medial margin of the fornix. (Confirmed by surgery.)

soft tissue shadows that can be observed in the air bubble may lead to error; because of this it is absolutely necessary to proceed with the method of ingestion of an opaque substance to confirm the diagnosis.

The tumor growths located in the upper third of the stomach often alter the esophagus, the stream of barium entering the stomach, and produce filling defects of



FIG. 4. A neoplasm that infiltrates and ulcerates the abdominal esophagus. Tumor shadow on the medial portion of the fornix.

different localization. As these alterations are conditioned by their location, it is justifiable to separate the following topographic types (Fig. 1, *A*, *B*, *C*):

(*a*) Massive, in which the invasion of the upper third is total.
(*b*) Tumors of the cardia and abdominal esophagus.
(*c*) Tumors of the medial margin of the roof above the cardia.
(*d*) Tumors of the upper part of the lesser curvature, immediately below the cardia.

(*e*) Tumors of the upper surface.
(*f*) Tumors of anterior and posterior surfaces.
(*g*) Tumors of the lateral margin.

(*a*) *Massive forms* (Fig. 2). The massive forms are generally easy to diagnose, as by occupying all or the major part of the upper third they are clearly visible to direct examination, and in supine position with opaque substance.

(*b*) *Tumors of the Cardia and Abdominal Esophagus* (Fig. 3 and 4). These tumors show, as their most notable feature, an obstruction to the passage of the opaque substance, with dilatation of the esophagus. The straight part is seen as a narrow channel frequently ulcerated and of irregular borders. Frequently the shadow of the tumor that invades the gastric roof can be seen.

(*c*) *Tumors of the Medial Margin above the Cardia.* This is the most frequent location of tumors of the upper third of the stomach. They are seen as shadows of soft tissues at this level and frequently deviate



Fig. 5. A tumor situated on the medial margin of the fornix over the cardia that displaces the lower part of the esophagus. (Confirmed by surgery.) The tumor mass is visible in the air bubble.



Fig. 6. *A*, a tumor of the medial margin of the fornix, above the cardia; it invades and compresses the abdominal esophagus. Its shadow can be seen in the air bubble. (Confirmed by surgery.) *B*, supine position. Filling defect in the tumor zone.

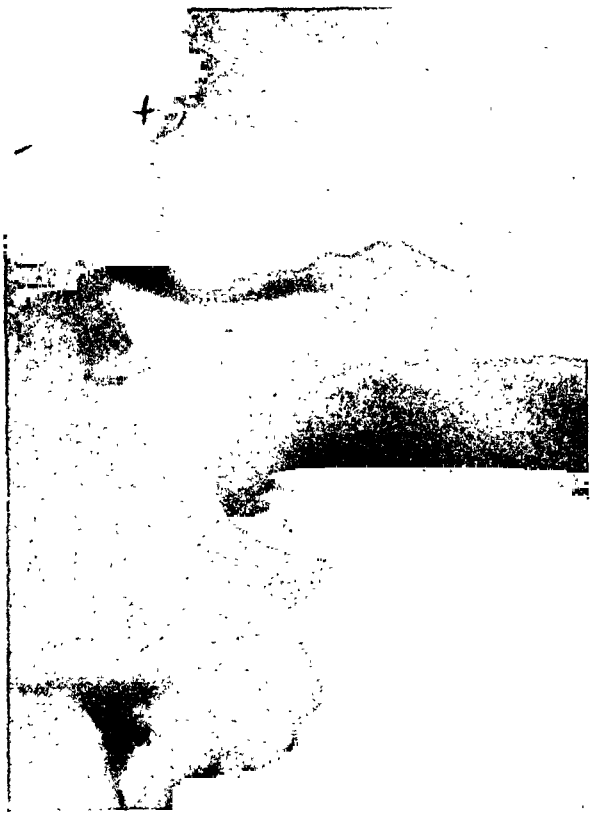


FIG. 7. Tumor situated at the upper part of the lesser curvature below the opening of the esophagus. The barium column that reaches the stomach is deviated upward by the tumor mass. (Confirmed by surgery.)

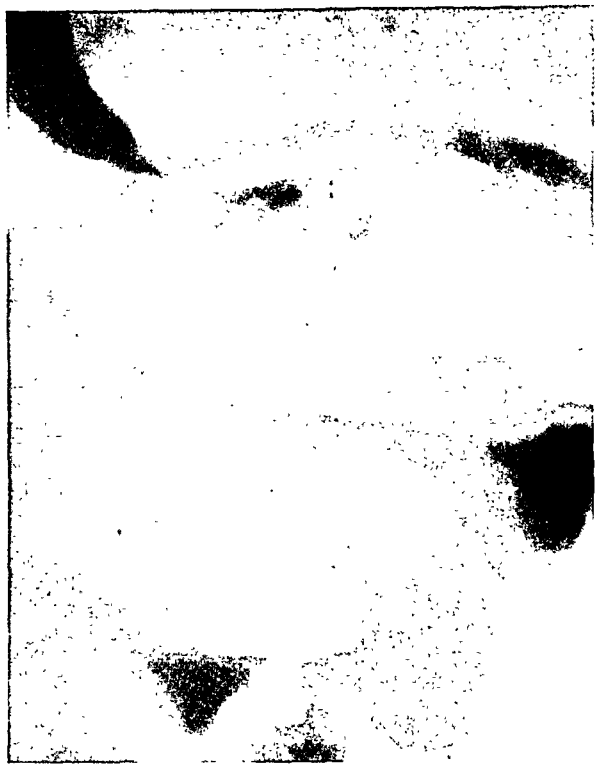


FIG. 8. The tumor mass divides the barium column into smaller streams. (Confirmed by surgery.)

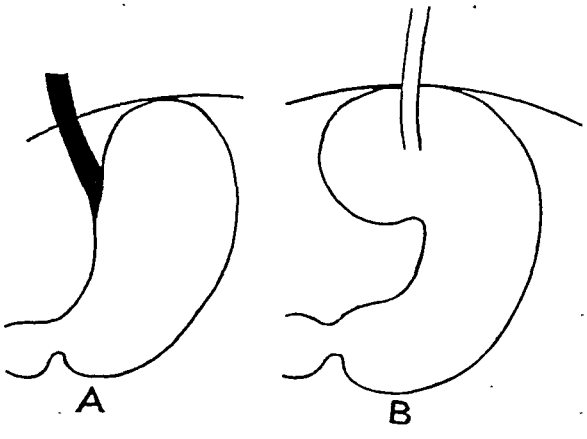


FIG. 9. *A*, the air bubble is of normal size. The study of the esophagus is possible because the air bubble is not superimposed. *B*, the air bubble is distended and superimposes its shadow on the esophagus.

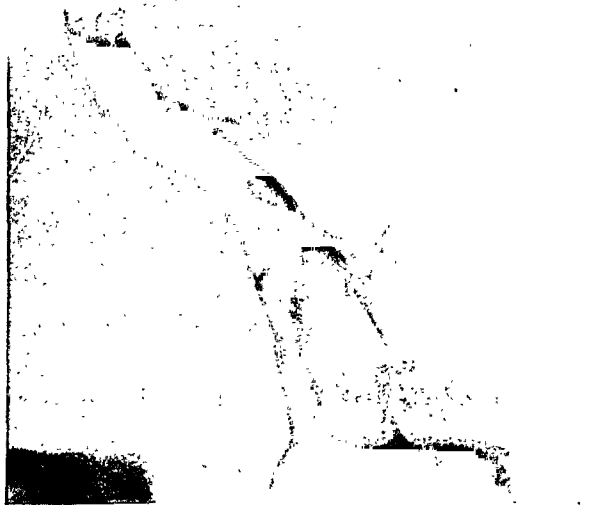


FIG. 10. Tumor of the upper border of the fornix. It deforms the dome of the diaphragm and increases the distance that separates the air bubble from the lung area. (Confirmed.)



Fig. 11. Tumor of the upper margin of the roof. A filling defect that corresponds to the tumor mass. The supine position is useful in this case because the tumor is marginal. (Confirmed.)

or press upon the abdominal esophagus that runs medial to them (Fig. 5). An examination with opaque medium, in supine position, either horizontal or in Trendelenburg, easily makes them evident (Fig. 6, *A*, *B*).

(*d*) *Tumors of the Upper Part of the Lesser Curvature Immediately below the Cardia.* These tumors either cause deviation of the opaque column that under normal conditions descends by the magenstrasse (Fig. 7), or they interrupt the flow of barium that enters the stomach, dividing it and forming small streams (Fig. 8). These segmentations of the barium column are projections of the tumor mass that obstructs the free flow of the ingested material. Normally the esophageal flow enters the



Fig. 12. Tumor of the anterior surface of the fornix. *A*, supine. Invasion of the esophagus by tumor. No typical filling defect is observed at the roof level. It must be remembered that the anterior surface is not marginal in this position. *B*, study in lateral Trendelenburg position; by showing the surfaces it accurately locates the tumor mass on the anterior surface. The filling defect at this level is evident. (Confirmed.)

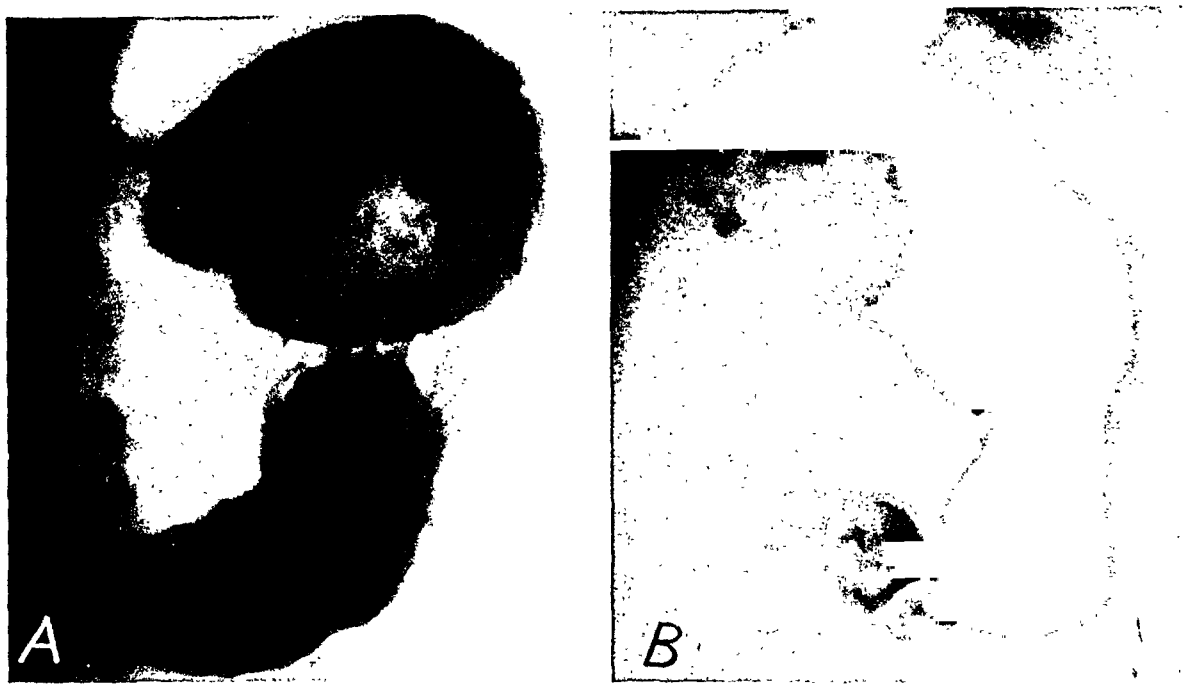


FIG. 13. Submucous tumor located on the highest part of the posterior surface. *A*, studied in Trendelenburg position. In this case the great size of the tumor allows it to be seen in the central part of the fornix. This position is not very useful for tumors that do not invade the lateral, medial or superior margins of the roof. *B*, the study is made in the lateral Trendelenburg position; by showing the surfaces it makes evident the location of the tumor on the posterior surface, with wide parietal implantation and an ulcer in its central part. (Leiomyoma.)

stomach without suffering any deviation and follows the lesser curvature the length of the magenstrasse (Fig. 9).

(*e*) *Tumors of the Upper Surface.* The tumors that develop on the upper surface of the fornix are, generally speaking, evident at direct examination, as their shadows are projected upon the lesser density of the pulmonary background and the transparency of the air bubble (Fig. 10). Also, in the case of these tumors the opaque substance in dorsal decubitus outlines the filling defect that the tumor mass produces, if it has reached a sufficient stage of development (Fig. 11).

(*f*) *Tumors of the Anterior and Posterior Surfaces.* In addition to the soft part shadows that these tumors give against the air bubble, they also produce filling defects of the barium mixture. However, because of their location they are not visible in supine position unless a very small portion of opaque substance is used. This is understandable as they are not marginal in this position and the barium covers them if their volume is not very great. In the Trendelenburg position in lateral decubitus, they are evident as marginal filling defects (Fig. 12, *A*, *B*, and 13, *A*, *B*).

(*g*) *Tumors of the Lateral Margin.* The tumors that arise in this site produce filling defects when the patient is examined in supine position. This is due to the fact that they are marginal in this position (Fig. 14).

DIFFERENTIAL DIAGNOSIS

As the tumors we have studied are seen as soft tissue shadows projected upon the air bubble and as filling defects of the opaque substance, the diagnosis must be made after taking into account all causes, normal or pathologic, intrinsic or extrinsic, that are capable of producing similar images.

(1) Normal elements at the upper third level which may produce false tumor images.

(*a*) Neighboring organs, such as the liver, heart, spleen, and so forth, may super-

impose their shadows upon the air bubble, in the anteroposterior view, making soft tissue shadows similar to those of the tumor. In the case where only a superposition of shadows exists, there is no filling defect when the examination is made with opaque substance. Also, the superimposed image is generally typical of the organ and its location; thus the liver is seen as a shadow at the inner third of the air bubble; the spleen at the outer third and the heart point is seen at the upper portion and changes with the respiratory movements.

(*b*) When the air bubble of the stomach is not properly distended, the folds of the walls may project shadows that give false tumor images; these disappear when the air bubble is filled by insufflation and remain unchanged if the shadows belong to true tumors.

(*c*) It has been said that a thickening of the shadow that separates the roof of the stomach from the diaphragm is a sign of



Fig. 14. Tumor of the lateral margin of the fornix. The examination in Trendelenburg position shows the filling defect clearly because the tumor is marginal in that position.

tumor of this area. Although this is a sign often seen in cases of tumor it is not to be solely relied upon, as it may induce error, since this thickness may vary under various circumstances. It is greater when the air bubble is not fully distended. Also, when there is an interposition of parts of the

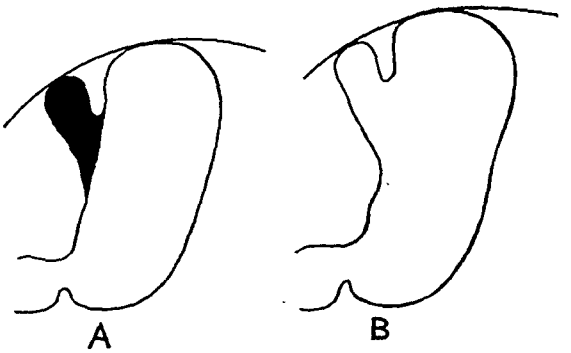


Fig. 15. When the cardia is patent, an examination of the standing patient shows the air bubble and the abdominal esophagus simultaneously filled with air; they are separated by a soft part shadow (incisura cardiaca) that can simulate a tumor. In *A* is seen the aspect of the gastric roof alone when the cardia is firmly closed. The abdominal esophagus (which has been marked in black) does not appear under these conditions. In *B* the cardia is patent and the abdominal esophagus fills with air.

liver or spleen between the roof of the stomach and the diaphragm and at other times, even through an optical illusion of increased distance in the anteroposterior image, when the superior margin of the stomach roof does not coincide with the highest point of the dome of the diaphragm.

(*d*) A jutting of the esophageal mucosa at the height of the cardia may produce a soft part shadow and defects of filling capable of simulating a tumor (Hodges, Snead and Berger[3]). It is similar to the phenomenon which is sometimes observed in the cecum at the level of the ileocecal valve.

(*e*) In the rare case of a widely open cardia, when the examination is made with the patient standing, both the air bubble and the abdominal esophagus fill simultaneously with gas. These then appear as separated by a soft tissue shadow that drops tongue-like from the roof of the stomach, which could be taken for a tumor

(incisura cardiaca) (Fig. 15). The inner part of the wedge is the terminal portion of the left side of the esophagus and the outer part is the initial portion of the greater curvature at the stomach roof level (Bársony).

(2) Voluminous mucous folds may produce filling defects of tumor-like character. The roentgen diagnosis in these cases is limited to the discovery of the filling defects without its being possible to establish their nature. In this respect Hinkel's case, in which a microscopic investigation was necessary to establish the non-tumor nature, is very illustrative.

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HYDATID DISEASE AND ITS ROENTGEN PICTURE

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ON EXAMINING a great number of patients with echinococcosis, one of the most striking features of the disease is the great variability of the clinical picture, which depends on the localization, vitality and evolution of the primitive parasite, the local complications by infection and rupture and, finally, on the existence and number of metastatic cysts in other parts of the body. This great variability restricts our possibilities of attaining full knowledge of the subject, especially as a great number of cysts cannot be visualized, obliging us to limit our description to those cases which we have seen roentgenologically.

Most authors who have written about *Echinococcus* refer to the high incidence of liver localizations, the percentage being between 55 and 65 per cent of the total, next the lung, with an incidence of 17 to 24 per cent. The remaining cases are divided among other organs, in order of frequency, particularly the bones, kidney and spleen, but practically any organ may be involved.

We have studied 120 cases distributed in the above mentioned order, to which we add for completeness some roentgenograms, which we owe to the kindness of Professor B. N. Calcagno, taken from the 350 cases the latter has seen at the Muñiz Hospital in Buenos Aires over a period of many years.

ECHINOCOCCUS CYSTS OF THE LIVER

For greater clarity and simplicity we propose the following classification of echinococcus cysts of the liver.

(1) Unruptured echinococcus cysts
 (a) calcified
 (b) non-calcified
(2) Infected echinococcus cysts
(3) Ruptured echinococcus cysts emptying
 (a) through the diaphragm into the bronchial tree
 (b) through the biliary ducts to the duodenum
 (c) into the digestive tract
 (d) into the peritoneal cavity (abdominal cysts)
 (e) through the skin (transcutaneous)

The liver cyst becomes calcified more often than the others and is therefore easily visualized. According to the site of the cyst and the extension of the calcification the appearance varies strikingly. The cyst can be completely calcified, being round or oval, with a more or less distinct outline; at other times only a reticulum of wide or narrow meshes can be seen (Fig. 1 and 2). The fact that only one solitary calcified cyst is visible does not exclude the possibility of the presence of other non-visible cysts. Calcification does not imply the biological death of the parasite nor freedom from a subsequent infection and its consequences; on the contrary, they tend to become infected very frequently. We have never seen, during many years of practice, an enlargement of the calcified cyst, a fact that denies the growth of such structures. Frequently several calcified cysts are visible (Fig. 3). The fact that we have never noted calcified intrahepatic structures of any other nature allows us to affirm that the existence of a round reticulated shadow in

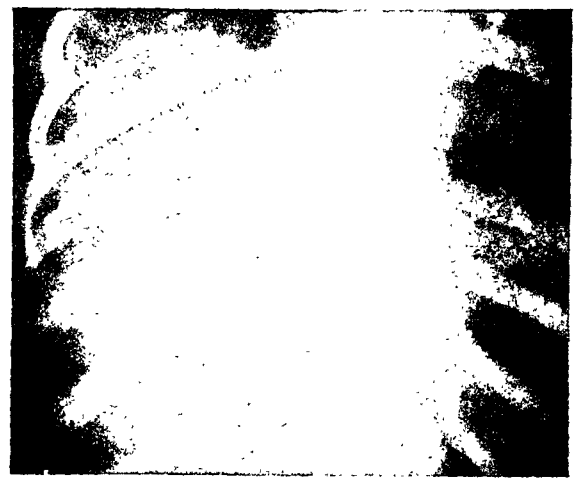


Fig. 1. Hydatid cyst of the liver partly calcified.



FIG. 2. Hydatid cyst of the liver completely calcified.

the liver is almost pathognomonic of hydatidosis.

The roentgenological difficulties arise in the diagnosis of those cysts with only a slight calcification of the capsule, appearing in the roentgenogram in the shape of fine round or oval lines (Fig. 4 and 5).

All livers containing echinococcus cysts are increased in size, the right hemidiaphragm is elevated, its excursion is impaired and it is divided into two or more arches. This latter is not exclusively characteristic of the disease and can be found more often in other diseases or even in normal conditions. Nevertheless, in endemic regions, round shadows, situated on the surface of the liver, deforming the diaphragm to a great extent point to hydatid disease (Fig. 6 and 16). Occasionally neo-

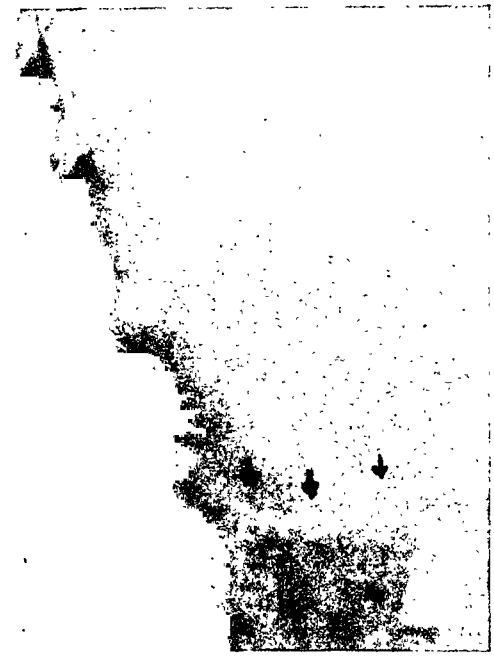


FIG. 4. Large hydatid cysts of the liver with partly calcified membrane.



FIG. 3. Several hydatid cysts of the liver calcified.



FIG. 5. Fine lines of calcification in the membrane of a large hydatid cyst of the liver.

plastic metastases to the liver show similar pictures.

Corresponding to the hepatomegalia the adjoining organs, like the stomach, duodenum and the hepatic angle of the colon, all of which can be shown easily by the roentgenogram, are seen to be displaced. Frequently the cysts are situated in the inferior border of the liver producing displacement in the adjoining organs in the shape of a crescent (Fig. 7 and 8). These can be so marked that sometimes they simulate defects, especially of the lesser curvature of the stomach (Fig. 9). These displacements give valuable information as to the location of the tumor. But we have also seen cysts, containing as much as 2 liters of liquid, which produced no real enlargement of the liver and no division of the diaphragm and so no displacement of the adjoining organs (Fig. 10).

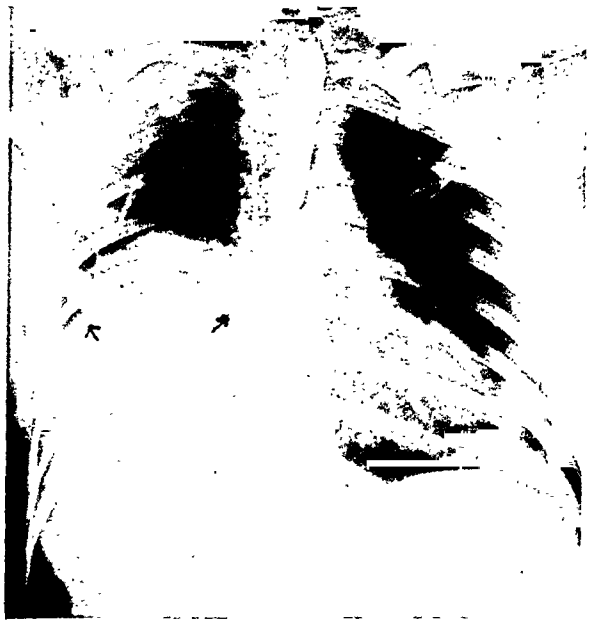


Fig. 6. On the inner side of the right diaphragm a round crescentic shadow caused by a hydatid cyst of the liver.

Sometimes liver cysts become infected without previous or subsequent perforation, forming pneumohydrocyst (Fig. 11, which shows a calcified double cyst, near the right diaphragm). This case healed after biological treatment, with diminution of the calcified region. Figure 12 shows a large pneumohydrocavity after operation.

Perforation of the liver cyst is not a rare occurrence and is nearly always accompanied by infection and a corresponding rise in temperature. But only in a case of an extensive perforation as, for example, into the digestive tract (Fig. 19), or into the bronchi (Fig. 18), is a pneumohydrocyst present.

The most frequent incidence of perforation is through the diaphragm and into the



Figs. 7 and 8. Crescentic shape of the hepatic angle of the colon due to displacement caused by a liver cyst on its lower surface.



FIG. 9. Apparent filling defect of the stomach due to compression by a hydatid cyst in the left hepatic lobe.

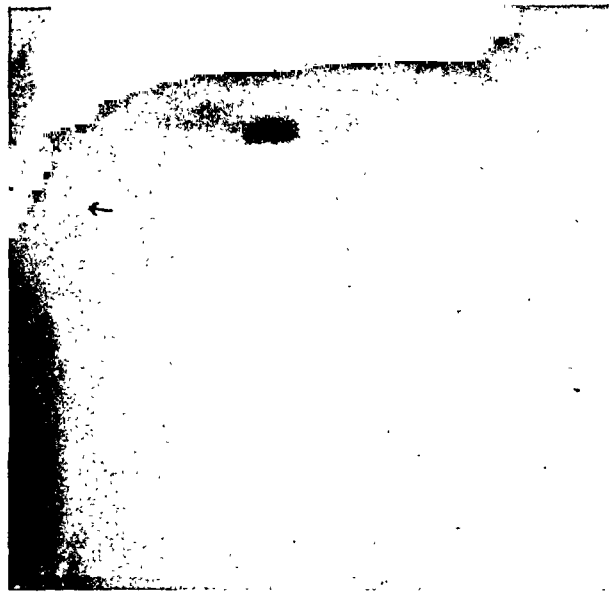


FIG. 11. Pneumohydrocyst of the liver without demonstrable rupture. Calcified membrane (arrow). (Archives of Prof. B. N. Calcagno.)

bronchi. As a preclinical symptom one often sees impaired movement of the right hemidiaphragm and a slight accumulation of fluid in the right costodiaphragmatic sinus and an enlargement of the liver (Fig. 13).

The basal pneumonia that extends up to the hilum appears as lines (Fig. 14) or as a dense shadow (Fig. 15). If the cyst is also visible, there is no doubt as to the exactness of the diagnosis (Fig. 14 and 16). Occasionally the basal pneumonia is so dense in the frontal view that it hides the diaphragmatic deformations, caused by the cysts (Fig. 15) and the suspicious rounded shadow is only visible in the lateral view



FIG. 10. Hydatid cyst of the liver, containing 1.5 liters, without apparent enlargement of the liver.

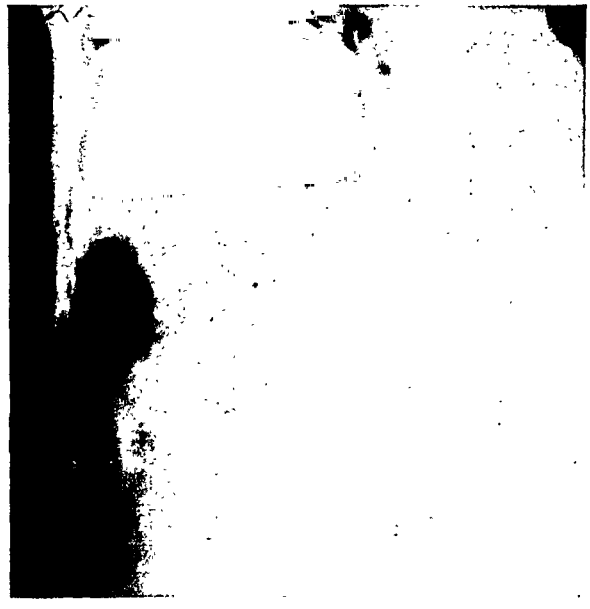


FIG. 12. Hydropneumatic cavity, three months after the removal of a liver cyst.



Fig. 13. Initial peridiaphragmatic perforation of a liver cyst. Large liver, some fluid in the right costodiaphragmatic sinus. Displacement of the stomach.

(Fig. 16). In these cases doubt arises as to whether it is a case of a perforated cyst of the base of the lung or the liver. Pneumothorax makes differentiation possible (Fig. 17), but this method is rarely employed, due to the great danger of pleural infection.

An ample opening of the cyst into a bronchus develops pneumohydrocysts in the liver (Fig. 18) with a membrane floating on the surface of the fluid.

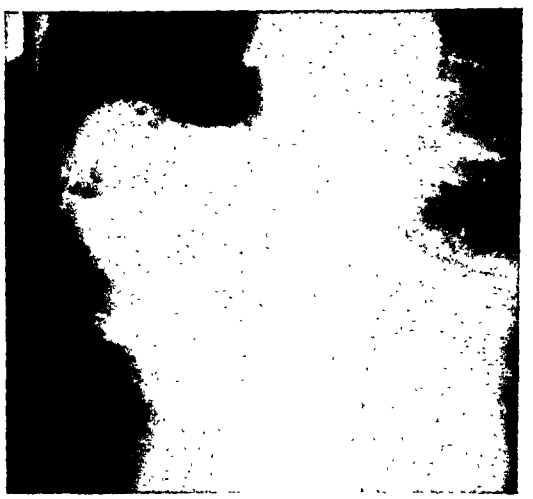


Fig. 14. Calcified liver cyst perforated into the bronchi. (Archives of Prof. B. N. Calcagno.)

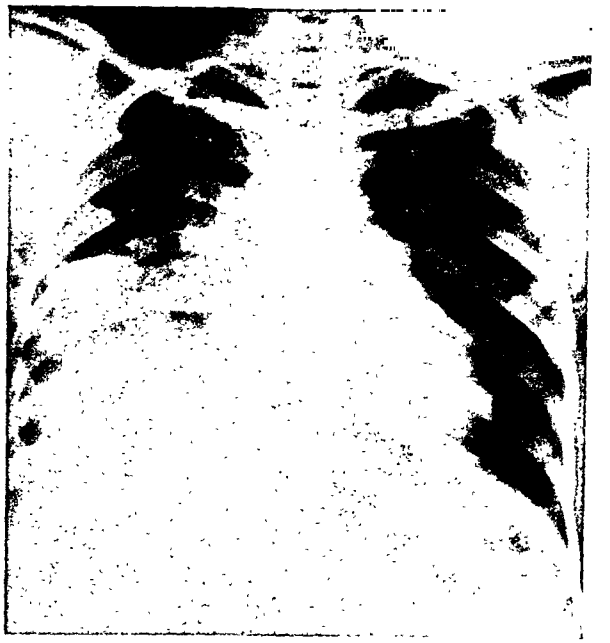


Fig. 15. Hydatid cyst of the liver perforated into the bronchi. Reactive basal pneumonia.

Perforation of the cysts into the bile ducts cannot be seen on roentgen examination.

Of course one can find occasionally a calcified cyst and nearly always displacements of the adjoining organs (we could never ob-



Fig. 16. Lateral view of the same case. Hydatid cyst visible.

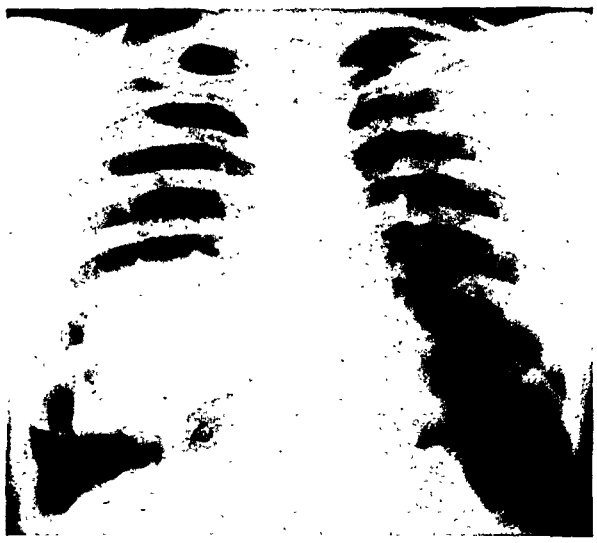


FIG. 17. Perforated lung hydatid cyst with pneumothorax, that proves its intrathoracic localization.

tain a positive cholecystogram in these cases). All this can help in arriving at a diagnosis, but only the presence of echinococcus hooks in the duodenal liquid is conclusive evidence.

Direct perforation into the digestive tract is rare. Figure 19 shows the dramatic picture of a perforation into the duodenum. The enormous pneumohydrocyst is clearly



FIG. 18. Pneumohydrocyst of the liver with floating membrane after perforation into the bronchi. (Archives of Prof. B. N. Calcagno.)

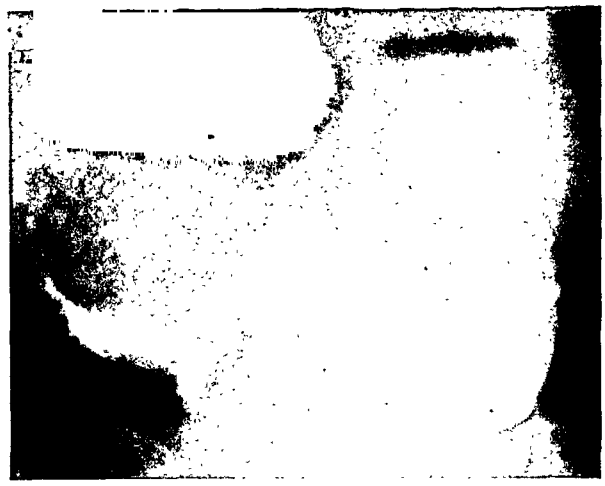


FIG. 19. Pneumohydrocyst of the liver after perforation into the duodenum. Floating membrane. Barium at the bottom of the cyst.

visible and also the membrane, floating on the surface of the liquid, in the form of an undulated line at the surface level known as the camalotes sign, which signifies a small floating island of tropical plants. The barium flows from the duodenum into the cystic cavity and settles down in the bottom of the cyst.

We saw another case of perforation into the hepatic angle of the colon with the same roentgen signs, the only difference being that the barium was carried by the enema through the intestine into the cavity.

We have seen cysts emptying through a fistula of the abdominal wall (transcutaneous). Filling with lipiodol showed a large

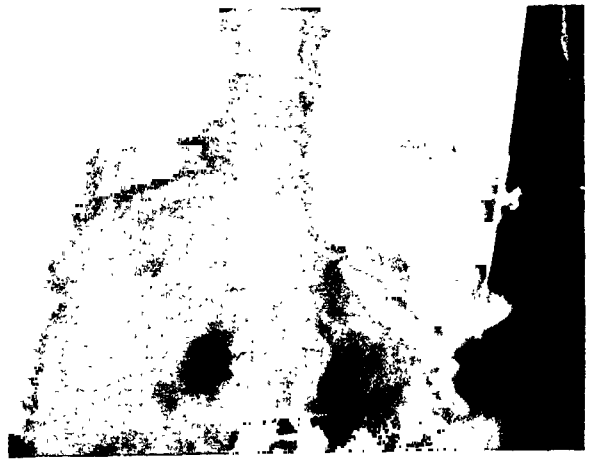


FIG. 20. Opaque filling of a fistula originated by a transcutaneous perforation of a liver cyst.

cavity and only operation revealed its hepatic origin. (Fig. 20).

ECHINOCOCCUS CYSTS OF THE ABDOMEN

In the opinion of many authors, multiple abdominal echinococcus cysts are usually the consequence of a rupture of a liver cyst into the abdominal cavity with the corresponding hydatid infection of the peritoneum. Usually they are accompanied by few clinical symptoms, which are easily missed. Years later the patient appears with a distended abdomen and symptoms of compression of the abdominal organs, the general state being unsatisfactory, sometimes with fever caused by suppuration of the cyst. Palpation of the abdomen gives the impression of an overfilled potato sack. Frequently the roentgenogram shows rounded shadows of the same density as the kidney (Fig. 21). More impressive are the displacements of the gastrointestinal tract, when filled by barium.

When the bladder, after injection with an opaque fluid, is seen to be displaced forward, metastatic cysts of the pouch of Douglas must be suspected (Fig. 22). Calcified abdominal cysts are rare. Pneumoperitoneum is not often employed for diagnosing cysts owing to the ensuing danger of tapping and its consequences.



Fig. 21. Abdominal hydatid cyst in the right lower abdominal region with soft shadow and dislocation of the kidney.

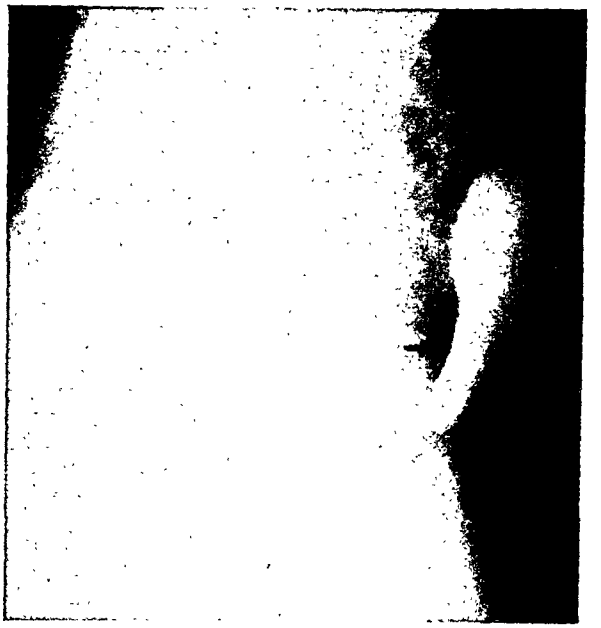


Fig. 22. Abdominal hydatid cyst in the pouch of Douglas with displacement of the opaque filled bladder. (Archives of Prof. B. N. Calcagno.)

ECHINOCOCCUS CYSTS OF THE SPLEEN

Those cysts of the spleen not calcified only give symptoms of displacement of the adjoining organs, due to the enlargement of the spleen (Fig. 23) Very great displacements can lead to doubt as to whether their origin is splenic or renal. Although the spleen usually displaces the splenic angle of the colon backwards, while the kidney displaces it forwards, sometimes not even a lateral view helps in making a differential diagnosis. The diagnosis is usually arrived at by means of pyelography, although the renal pelvis can be displaced and deformed by a large spleen, being indistinguishable roentgenologically from a closed cyst of the kidney.

ECHINOCOCCUS CYSTS OF THE KIDNEY

This is a more frequent occurrence and produces very illustrative findings. The simple roentgenogram shows great enlargement of the kidney, at other times only the



FIG. 23. Splenic cyst with displacement of the adjoining organs.

superior pole is enlarged. Occasionally calcifications can be seen (Fig. 24). The adjoining organs are always displaced. The pyelogram shows great deformity of the pelvis and the calices (Fig. 24). The picture is more clear cut if the cyst opens into a calix and through this medium into the urinary tract. In these cases the cavity fills with the opaque fluid (Fig. 25). Figure 26 shows a rare picture, where daughter cysts can be seen in the pelvis and another, deformed one, at the origin of the ureter and a third one in the bladder.



FIG. 24. Closed calcified hydatid cyst of the kidney with extensive deformation of the renal pelvis and of the calices.

ECHINOCOCCUS CYSTS OF THE BONES

These are very rare and we have seen only 4 cases, but Professor B. N. Calcagno has shown us 30 cases. At the beginning, when the involved bone is unchanged,



FIG. 25. Hydatid cyst of the kidney perforated into the renal pelvis.

either by infection or by operation, the roentgen appearance resembles surprisingly a giant cell tumor. The corresponding bone segment seems blown up and riddled with cavities (Fig. 27). The cortex is well preserved, although no reparative reaction of any kind is seen. At the same time in one case there was a large abscess in the axilla. We have never seen both appearances in giant cell tumor. Aspiration showed the remains of membranes.

If the cyst grows for a time, it invades the adjacent bones and soft parts with no respect for the anatomical limits. Extensive cyst defects, involving the adjoining bones and invading the cortex are frequent



Fig. 26. Calcified perforated hydatid cyst into the upper kidney pole with only slightly deformed pelvis. Daughter cysts visible in the pelvis, ureter and bladder. (Archives of Prof. B. N. Calcagno.)

in the pelvis and femur. Pathological fractures and small formations of sequestra in the adjacent soft tissue are frequently seen (Fig. 28). Lung cysts sometimes coexist.



Fig. 27. Hydatid cysts of the scapula. Blown bone, riddled by cystic defects. No reparation. Small sequestrum in the upper border of the scapula. (Archives of Prof. B. N. Calcagno.)



Fig. 28. Widespread hydatid cysts of the femur with pathological fracture and spotted shadows of the soft parts.

After surgical intervention the formation of fistulae and secondary osteomyelitis is frequent. A tendency to bone condensation and the disappearance of the cysts either totally or partially gives a misleading roentgen picture (Fig. 29). Otherwise, one sees extensive operative bone defect, not rarely combined with bone fracture and progres-

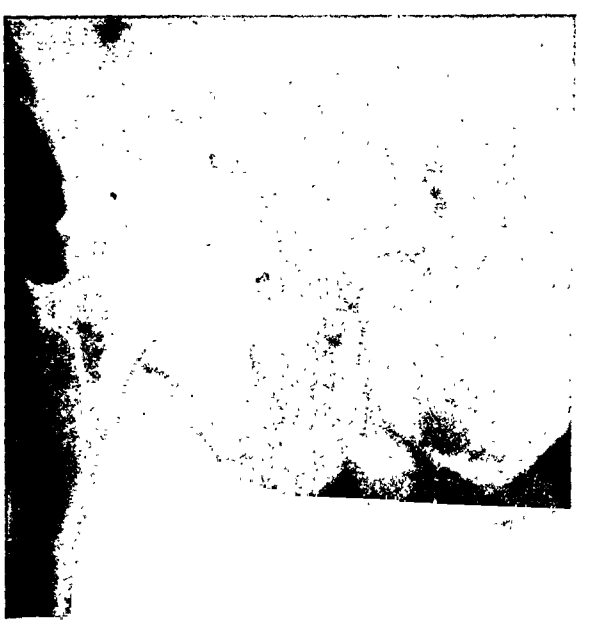


Fig. 29. Hydatid cysts of the pelvis, years after operation with numerous fistulas and membrane evacuation. Around the articulation osteomyelitic condensation of the bone. Cystic formation in the blown pubis and ischium. (Archives of Prof. B. N. Calcagno.)



FIG. 30. Hydatid cysts of the pelvis and femur, years after the operation. No osteomyelitis. Defects caused by operation and fractures. Cystic defects at the edges.

sion of the cyst towards the periphery (Fig. 30).

Especially difficult is the roentgenological diagnosis of the relatively frequent echinococcosis of the spine. Though the roentgen signs are insignificant at the beginning, it clinically produces the most alarming symptoms, originated by an extensive and plane infiltration of the meninges by cysts. Spinal blocks occur early (Fig. 31) and this is clearly visible after the myelography. Frequently one sees in the initial stage a partial destruction of the transverse processes, far below the block (Fig. 31) and a small, clear, bubble-like area of the lower adjacent vertebral body

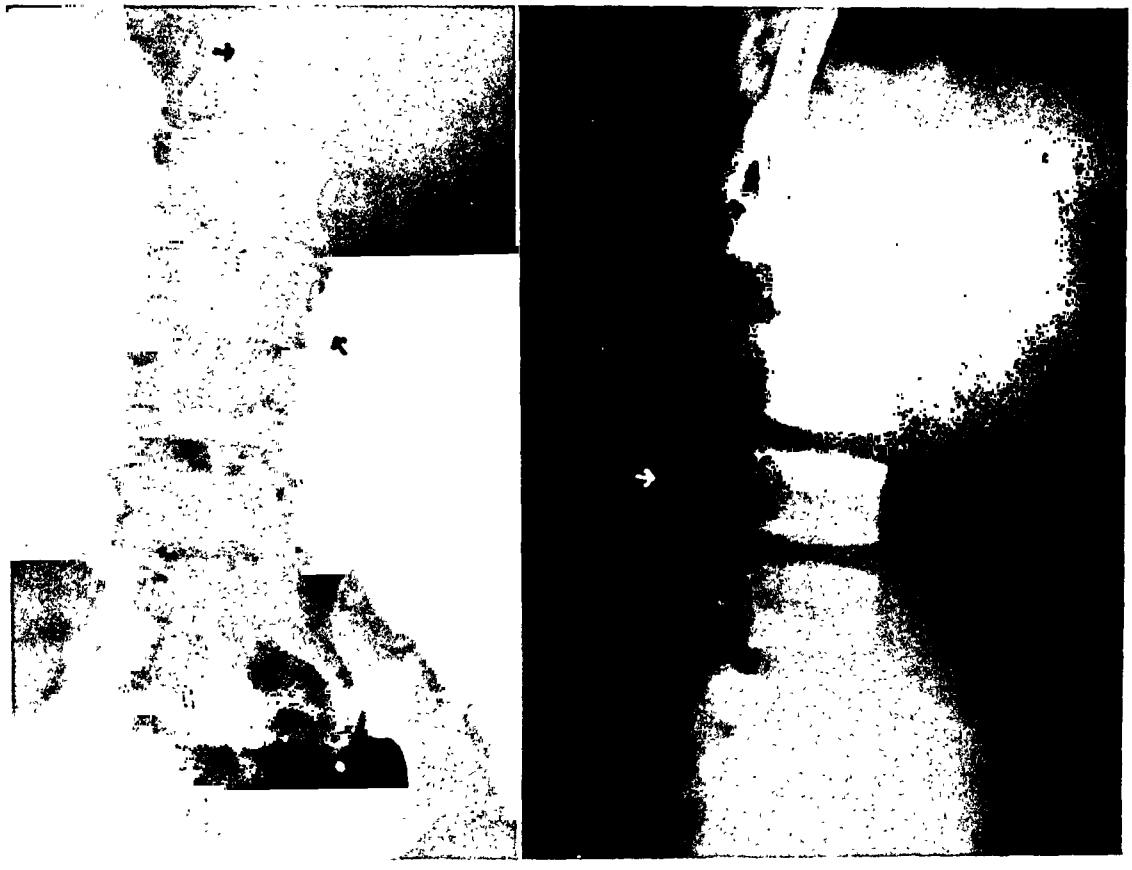


FIG. 31 FIG. 32

FIGS. 31 and 32. Initial hydatid cysts of the spine, destruction of the left transverse process of L_3 (Fig. 31) and bubble-like area of the vertebral body of L_3 (Fig. 32). Lipiodol block at the height of L_1. (Archives of Prof. B. N. Calcagno.)

(Fig. 32). Ossifluent abscesses are frequent and can be seen early in the dorsal spine (Fig. 33). The intervertebral discs escape involvement for a long time. If the disease progresses, destruction increases, the bubble-like character of the bone lesion disappears, the destruction progresses and attacks many vertebrae, but shows no tendency to destroy the disc (Fig. 32). With formation of spontaneous or operative fistulas, the roentgen picture becomes blurred by the accompanying osteomyelitis (Fig. 34).

HYDATID CYSTS OF THE LUNG

Twenty-two per cent of our cases have been found in the lung. The closed ones are roentgenologically different from the open ones. The closed cyst, which usually does not contain daughter cysts, appears roentgenologically as a round homogeneous shadow in the lung parenchyma (Fig. 35). This cyst, being of an expansive nature, makes the intercostal spaces bulge. The ribs are hidden by the opaque cyst shadow. The bone is not eroded, as it is in the extrapulmonary cysts of the pleura (Fig. 33).



Fig. 34. Repeatedly operated hydatid cysts of the spine with fistulae. The picture is blurred by the concomitant osteomyelitis. The intervertebral discs are destroyed. (Archives of Prof. B. N. Calcagno.)



Fig. 33. Extensive destruction of the right side of the 5th, 6th, 7th and 8th thoracic vertebrae and the corresponding ribs. Ossifluent abscess. Artificial shadow at the height of Th_4. Finding at operation: Extrapulmonary hydatid cyst of pleura with lesion of the bones caused by compression. Biopsy of the bone does not show hydatid invasion.



Fig. 35. Round sharply defined shadow of hydatid cyst in the right lung.



FIG. 36. The same case in lateral view shows polycyclic formation.

We have never seen calcified lung cysts and know of only one case in the literature. The movements of the diaphragm are seldom interfered with. As the cyst grows, it often loses its roundness and becomes polycyclic, being more often visible in lateral views (Fig. 36). The sharp limits disappear, due to a thickening of the pericystic membrane. These fibrous lines radiate into the surrounding lung parenchyma and also obscure the cystic image (Fig. 37). These findings make a differentiation from other round lung tumors diffcult. It is obvious that other roentgen signs must be found for a differential diagnosis. The first and simplest way is to look for other possibly calcified cysts, for they are quite frequent in the liver. If these are not found and other clinical symptoms do not give further help, one has recourse to bronchography.

There is no doubt that the *Echinococcus* only causes displacement of the bronchi that surround the cyst in a rather typical manner like a hand grasping the tumor in its fingers. Only the smallest bronchi are not permeable, owing to the compression, and they end in a point. It is a fact that the same deformity of the bronchi is caused by all benign tumors. But these latter being extremely rare, the presence of this sign in an endemic region arouses suspicion of hydatid cyst. But at times true bronchial block image is found in bronchograms of cysts. We have seldom used bronchography.

Other positive signs are the surprising movements and deformities of the soft and liquid containing cysts, which accompany changes in the position and in deep breathing. Unfortunately this sign is not of much help, because this form of deformity is also seen in other tumors. It is not real change in the shape of the tumor, but an altering of the roentgen shadow, due to change in position.

The existence of large round shadows in both lungs makes the diagnosis of hydatid cyst almost certain (Fig. 38).

Small multiple cysts, in both lungs, cannot be differentiated roentgenologically from metastatic neoplastic processes (Fig. 39). Although multiple cysts are really metastatic processes, we saw the appearance in 2 cases three months after the removal of liver cysts, the lungs having been free of cysts before operation. If a cyst bursts,



FIG. 37. Multiple hydatid cysts in the middle and lower part of the left lung. The shadow, adjoining the hilum shows network of lines.



Fig. 38. Large bilateral lung cysts with *irregular border.*

and the level of the liquid is visible in one of the multiple round shadows, then the roentgen diagnosis is assured (Fig. 40), but in these cases, the clinical and the laboratory findings have decided the question beforehand.

The rupture of a lung cyst is sometimes foretold by the appearance of a pericystic emphysema. Above the cystic shadow and sometimes behind it there appears a transparent air shadow, in the shape of a crescent, which corresponds to an accumulation of gas between the pericystic and the cystic walls (Fig. 41). Sometimes the emphysema is so small that it can be seen only by tomography. Though Professor F. Dévé states that a peritumoral emphysema can be found also in non-cystic tumors, the sign



Fig. 39. Small spotted metastatic lung cysts.



Fig. 40. Small spotted metastatic lung cysts. On the left side a pneumohydrocyst.



Fig. 41. Pericystic emphysema. One sees a convex border not altered by changing position (no fluid). (Archives of Prof. B. N. Calcagno.)



FIG. 42. Dry membrane at the bottom of a pneumocyst. Right above large round hydatid cyst.



FIG. 43. Same case. The pneumocyst is resorbed and the membrane lies in a closed cavity (incarcerated membrane). The large cyst, right, above, has burst causing a pneumonic massive infiltration. (Archives of Prof. B. N. Calcagno.)

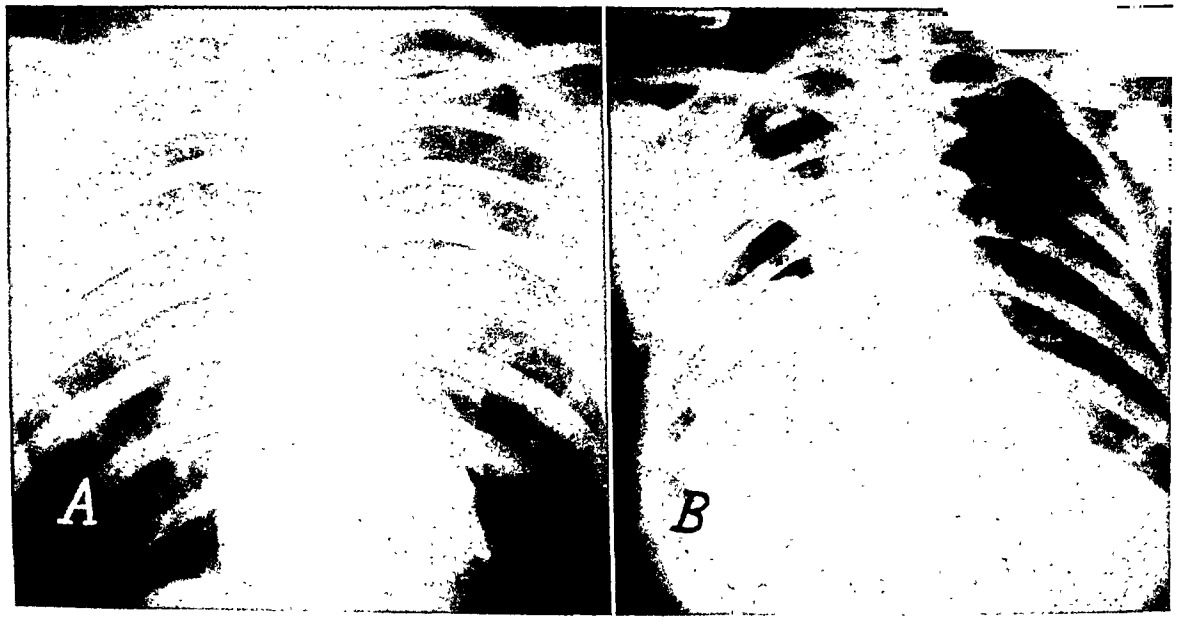


FIG. 44. *A*, floating membrane in a hydropneumocyst. *B*, sign of double arch. (Archives of Prof. B. N. Calcagno.)

is very useful for diagnosis of echinococcus cyst. It is not certain whether it originates through a communication between the bronchus and the pericystic cavity, or from the rupture of an adjoining emphysematous bulla. It could also be caused by the shrinking of the echinococcus cyst after its degeneration. This pericystic emphysema signifies the death of the parasite. Clinically this phase manifests itself by small hemoptyses.

The clinical evolution, as well as the roentgen signs, varies. Sometimes there is a progressive drying and reduction in size of the cyst. Roentgenologically the pericystic emphysema persists, the parasite diminishes in size and becomes transparent and its membrane folds up and falls to the bottom of the cavity (Fig. 42). This process is progressive until all the air of the cavity is resorbed. The pericystic membrane lies close to the cystic membrane (incarcerated membrane, (Fig. 43).

Sometimes this clinical and roentgenological picture remains at this stage for years. More frequently there is reactivation and suppuration with abscess formation.

Rarely the shrunken cyst bursts and pours out some fluid giving a surprising roentgen picture (Fig. 43). The superior



Fig. 45. Floating membrane in a pneumohydrocyst. Extensive accompanying pneumonia.

rounded border corresponds to the lung substance. Below there exists a transparent crescentic area, corresponding to the pericystic emphysema, bounded below by a fine line, which is the pericystic membrane. The cyst contains some air and liquid (hydropneumocyst with floating membrane). This is called the sign of the double arch.

In other cases the rupture of the cyst is accompanied from the beginning by marked and widespread inflammation and ate-



Fig. 46. Hydropneumocavity. Immediately (left) and years after operation (right).

lectasis of large areas of the lung. The round cyst shadow (Fig. 42, above) changes in a few days into a compact lobar shadow (Fig. 43, right above, being taken from the same patient, as the previous roentgenogram) which shows no cavity either in the tomogram or in a penetrating roentgenogram, because the cavity is full of liquid. In these cases bronchography sometimes is enlightening.

In other cases one sees in the infiltrated lung parenchyma a pneumocyst or a hydropneumocyst, in rare cases with camalotes (Fig. 45).

The further development of the described cavities is different. Some disappear without treatment, others with biological treatment and yet others need pneumothorax or surgical intervention. Figure 46 shows postoperative hydropneumocavity which is nearly unchanged after three years, although the resected rib had time to regenerate.

I would like to express my very grateful thanks and appreciation to Professor B. N. Calcagno and his very able assistant Dr. J. C. Casiraghi for their invaluable and most unselfish help, in furnishing me with some of their best material.

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IRRADIATION OF PITUITARY TUMORS*

RESULTS IN FIFTY CASES

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THE object of this paper is two-fold: (1) to present the general subject of the diagnosis and irradiation of pituitary tumors and (2) to report the results of a follow-up survey of 25 cases presented in 1941, with a review of an additional series of 30 cases.

Embryologically the pituitary body or gland is developed from two sources. The anterior or glandular portion is derived from an upgrowth of the pharyngeal mucosa known as Rathke's pouch or the craniopharyngeal duct, while the posterior portion develops from a downgrowth from the floor of the third ventricle and is of nervous origin. The craniopharyngeal duct ordinarily disappears but rests may remain in any part of its course and these may later give rise to cystic or solid craniopharyngiomas or Rathke's pouch cysts or tumors. These ordinarily occur in the suprasellar region but may also be found within the pituitary body and masquerade as tumors of the hypophysis itself. This must be kept in mind when dealing with cystic tumors. The pars intermedia is an epithelial structure which covers the posterior portion and lines the gap which separates the anterior from the posterior "lobe."

The anterior lobe is composed of chromophilic and chromophobic cells formed in columns and surrounded by large blood spaces. The chromophilic cells can be divided into eosinophilic and basophilic types; the former are more abundant in the center of the gland while the basophilic cells are more numerous at the periphery.

Physiologically, the anterior lobe cells have mainly to do with growth and sexual development while the posterior lobe elements are concerned with carbohydrate metabolism and consequently development of fat.

In this study we are interested in the tumors or hyperplasias which develop in the anterior lobe and which because of their size, or abnormal hormone secretion, or both, cause a variety of symptoms.

The diagnosis of pituitary tumor is usually made by the neurologist or ophthalmologist in consultation with the radiologist, although, because of symptoms referable to the thyroid, the patient may first consult an internist or possibly an orthopedist, if weakness of the back is an early symptom, as it may be when growth is rapid.

I shall consider first eosinophilic or acidophilic tumors. These lesions are suspected mainly because of their hormonal activity which is usually of the growth type. If the tumor occurs before the closure of the epiphyseal lines, the patient develops gigantism. With the development of gigantism, complaints of a weak and somewhat painful back may also be present. If the tumor develops after normal growth has ceased, acromegaly is the result—large hands and feet, prominent jaw, enlarged head and sinuses. It must also be remembered that there may be an increase in the thyrotropic hormone with a resultant increase in the basal metabolic rate and diffuse enlargement of the thyroid gland. We have seen 2 such cases, in 1 of whom the basal metabolic rate became normal after irradiation. Patients with acidophilic pituitary tumors may also complain of headaches and study of the visual fields frequently shows bitemporal cuts, which indicates pressure on the optic chiasm. Occasionally no changes whatsoever can be found in the fields. In our ex-

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perience, approximately 60 per cent of the cases of acidophilic tumor of the pituitary showed roentgenographic evidence of enlargement or erosion of the sella turcica. Amenorrhea and loss of libido are mentioned as of frequent occurrence but in our experience these have not been of outstanding importance. Increased sexual activity in both sexes is said to be present early with this type of adenoma. Headache, however, may be the presenting symptom. These tumors do not ordinarily become as large as chromophobic adenomas because their symptomatology is more arresting.

The chromophobic cells have no definite known function and a tumor composed of this type of cell produces signs and symtoms due to its size alone—i.e. pressure symptoms. These may be (1) headache, because of pressure on the sella and diaphragma sellae. Following a considerable period of increasing severity, there may be relatively sudden relief from headache due probably to rupture of the diaphragm or fracture of the dorsum sellae with release of pressure. This loss of headache must not be thought of as improvement in the patient's basic condition, however. (2) Increase in the size of the tumor causes increased pressure on the acidophilic group of cells with resultant atrophy and the development of hypopituitarism. This results in weakness, fatigability, decrease in libido in the male and amenorrhea and sterility in the female. These changes may be so insidious, however, that the tumor may go unrecognized until it has reached sufficient size to press upon the optic chiasm. When this occurs, changes are noted first in the superior temporal quadrants of the visual fields. The slowness of development of this symptom accounts, no doubt, for the fact that almost complete loss of the temporal fields may occur before the patient is aware that he is losing his vision. If there is extension of the tumor laterally and posteriorly, there may be involvement of the third, fourth and sixth nerves with resultant ophthalmoplegia. In our experience, increased intracranial pressure beyond that confined within the sella is practically unknown. This is said by some to occur commonly but in only 2 of our cases was there any suspicion of such an occurrence. Types I and II may also occur together and form a mixed group of cases.

The third general type of pituitary tumor is the basophilic adenoma which causes the well known but infrequently seen cases of Cushing's basophilism. These tumors are small, cause no enlargement of the sella and ordinarily no headache. The cardinal symptoms are change of facies, hirsuitism, hypertension, abdominal striae, painful adiposity of the face, neck and trunk and sexual dystrophy. It must be remembered that a similar syndrome can arise because of certain adrenal tumors.

TREATMENT

The original treatment for tumors of the pituitary gland was surgical and occasionally this method is still used primarily. More and more, however, it has become recognized that irradiation should be used first, and only if this fails should the patient be operated on. Gramegra, in 1909, is usually credited with having been the first to use irradiation for the treatment of a pituitary tumor. The first permanent result, however, was probably in a case treated by Béclère. His patient, treated in 1909, was well twenty-two years later.

Our method of treatment is radically different from most other present day techniques only in that we do not give repeated courses but try to deliver to the tumor in one course all the radiation which is necessary to cause regression, just as we do with malignant tumors. This consists of treating through four fields directed toward the sella turcica—two temporal, one frontal and one vertical. We use 200 kv., with a quality of 1.95 mm. Cu half-value layer, 50 cm. distance and a 5 cm. cone. One hundred roentgens are given to one field the first day in order to reduce to a minimum the chances of causing swelling with increased intracranial pressure and

headache. If no reaction ensues, two fields are given 100 roentgens each the second day and from then on 200 roentgens are given to each of two fields per day. This is carried up to a total of 2,000 roentgens per field (air dose). With the ordinary sized calvarium, this delivers approximately 2,400 roentgens into the pituitary fossa. There is, of course, temporary epilation over the treated hair-bearing area but we have never seen the epilation become permanent. Until about five years ago, we treated these cases over an additional occipital field and carried the total air dose to 9,000 roentgens. We also sometimes used fields larger than 5 cm.—usually 6 by 8 cm. This gave a considerably larger tumor dose which was routinely between 3,000 and 3,600 roentgens.

In the previous report, we divided our results into "excellent," "good" and "poor" depending upon whether (1) there was an increase in visual fields, loss of headache and general improvement in the patient's over-all condition, (2) arrest of the process with loss of headaches and (3) no demonstrable good effects of the treatment. The results of the treatment of 25 cases at that time were reported as excellent, 56 per cent; good, 20 per cent; poor, 24 per cent. All but one of the living cases have been followed. One case was proved not to be a tumor of the pituitary so the series is reduced to 24 cases of which 14 (58.3 per cent) had excellent, 5 (20.8 per cent) good, and 5 (20.8 per cent) poor results, or excellent and good 79.1 per cent. Of the 5 failures, 1 died fifty-two months after having shown improvement for nineteen months; 1 died one month following treatment; 1 died with cerebral symptoms attributed by us to a combination of hypertension and irradiation; and 2 were unimproved and at operation cystic tumors were found. These 2 cases have done well postoperatively.

The second series is not quite so easy to evaluate because 2 of the patients were too sick to tolerate treatment and are excluded from the series studied statistically. Two others were admitted from institutions for the insane and were obviously psychotic. They were also practically blind. Although they are both living, the mental deterioration has progressed and blindness was not affected. They also have been omitted from the series. That leaves 26 cases and of these 15 (57.7 per cent) had excellent, 3 (11.5 per cent) good, and 7 (26.9 per cent) poor results; or excellent and good 69.2 per cent, poor 30.7 per cent.

For the entire series of 50 cases, 29 (58 per cent) had excellent results, 6 (12 per cent) had good, and 15 (30 per cent) had poor results; or 70 per cent excellent and good results.

Of the total of 50 cases being reported on, there are 11 acidophilic, 1 basophilic, 37 chromophobic and 1 mixed acidophilic and chromophobic. Seventy-two per cent of the acidophilic group did well while 70 per cent of the chromophobic tumors had excellent or good results. Our 1 case of basophilic tumor did poorly. The ages ranged from eleven to seventy years. Twenty-six of the total series were women and 28 were men and boys.

COMMENT

We think that all types of pituitary tumor—acidophilic, basophilic, and chromophobic—should receive primary irradiation. It has been said many times that only acidophilic adenoma is sensitive to irradiation. With this we do not agree. The chromophobic does equally well. There are at least three suspected conditions, however, which we think should make one defer radiation therapy: (1) suspicion of a cystic tumor, (2) symptoms of hemorrhage into the tumor and (3) increased intracranial pressure. It is almost universally agreed that it is futile to irradiate a cystic tumor. The tumor may be cystic because of a developmental anomaly arising from remnants of the craniopharyngeal duct, from degeneration of the tumor, or from an old hemorrhage. It is almost impossible, however, to be at all sure that one is dealing with a cystic tumor before irradiation or surgical interference. It is of the utmost im-

portance that patients having any constriction of the visual fields should have these tested frequently and if there is continued decrease in the fields two months following the cessation of therapy, operation should be advised at once. It must be remembered, however, that there is not uncommonly an early further constriction of the fields during irradiation and this should not deter one from giving the full course of treatment.

It is easier to suspect recent hemorrhage into a tumor because there is a history of an acute episode, following which there is sudden onset of visual disturbance. We have seen one such case during the past year. Only once have we suspected a cystic tumor in time to refuse to give irradiation. I must stress again the necessity of careful repeated visual field determination up to at least two months following cessation of the irradiation. Increased intracranial pressure is of such infrequent occurrence in our experience that it is not much of a factor. Should it occur, however, I think that the primary approach should probably be surgical with postoperative irradiation.

The diagnosis of adenoma of the pituitary is not always as simple as it seems. In the cases of acidophilic tumor one must rely on the signs of growth disturbance, secondary hypopituitarism or perhaps secondary changes in the thyroid. Enlargement of the sella turcica and visual field changes are not necessary. When diagnosing chromophobic adenoma, however, we have three times encountered difficulty. The first case had an enlarged sella, visual field changes and headaches and was diagnosed as a case of pituitary tumor. Following irradiation, he did well for five years. He then had recurrent difficulty and operation revealed an epidermoid carcinoma of the pineal. This is the case that was removed from the 1941 series. The second was a fat boy with enlargement of the sella and field constrictions. For about a year he showed improvement following treatment. He then became worse and died promptly. At autopsy, his osseous system was found riddled with Ewing's tumor. The third case was a man with a large sella and all signs of pituitary tumor of the chromophobic type. Because of bronchiectasis and blood streaked sputum, he had a bronchoscopy which revealed an epidermoid carcinoma of the bronchus. His intracranial lesion was undoubtedly metastatic.

Whereas it now seems wise to institute radiation treatment for all uncomplicated cases of pituitary tumor—and by uncomplicated I mean without hemorrhage or with no suspicion of cyst formation—it appears logical to lean heavily on the neurosurgeon when these complications occur or are suspected. Thus all cases not showing adequate response in two months should be operated on, and cases operated on primarily should have postoperative irradiation because ordinarily not all of the tumor can be removed without sacrificing at least one of the optic nerves. Four of the irradiation failures that were operated on have remained well for from 54 to 103 months. There were 3 postoperative deaths.

COMPLICATIONS

Camp has reported several cases of radiation necrosis of the skull following treatment for pituitary tumor. So far we have seen only one case of radiation necrosis of the skull and that was in a case we had treated intensively for a brain tumor—not pituitary. Our experience with more than 50 cases indicates that the danger of this complication is small and can be essentially disregarded, if the technique outlined above is used.

In irradiating the brain with heavy doses we must be careful not to exceed the usually accepted maximum tissue dose of from 4,500 to 5,000 roentgens. We have never seen any indication of damage to the brain in the treatment of such lesions, even at autopsy, as we have following intensive treatment for glioma of the brain. Perhaps twice, we have seen symptoms suggesting increased intracranial pressure following

TABLE I

Case	Name	Age	Sex	Signs and Symptoms	Tumor Type	Treatment	Progress	Months Followed Result
1	C. A. First series	69	M	Diplopia; failing vision for 4 mo.; bitemporal hemianopsia; enlarged sella; vos 6/12; vod 6/15 plus 2	Chromophobe	Oct. 1938. Tumor dose 2,546 r in 27 days	Visual fields enlarged 2 mo. after treatment. Unchanged, thereafter. Died 12-18-39 of proved coronary occlusion	14 mo. Good
2	L. A. First series	43	M	Failing vision for 1 yr. with blindness os 6 mo.; occipital headaches; temporal hemianopsia od; enlarged sella	Chromophobe	Feb. 1934, 1,600 r in 15 days. Dec. 1934, 2,457 r in 23 days. April, 1935, 1,931 r in 19 days. Total: 5,988 r in 14 mo.	Vision improved after 9 mo. Gradually improved. Vision in blind eye returned to ½ field	144 mo. Excellent
3	N. A. Second series	31	F	Increase in size of hands and feet for 18 mo. Decrease in lateral vision	Chromophobe? Mixed?	Nov. 1941, 8,000 r in 28 days. Tumor dose 2,643 r	Increase in fields to normal	54 mo. Excellent
4	W. A. First series	62	M	Headaches for 8 mo.; diplopia for 3 mo.; ptosis for 1 mo.; ophthalmoplegia; destruction of sella and of anterior portion of foramen magnum	Chromophobe	Aug. to Oct. 1939, 3,831 r in 47 days	Headache improved. No ptosis of right upper lid. Felt generally better	20 mo. Good
5	A. B. Second series	34	M	Acromegaly	Acidophilic	June 1940, 8,600 r in 26 days. Tumor dose 3,500 r	No progression of symptoms. Good vision	72 mo. Excellent
6	W. B. Second series	35	M	Visual loss	Chromophobe	May 1941, 9,000 r in 28 days. Tumor dose 3,217 r	Gradual improvement	61 mo. Excellent
7	W. B. First series	44	M	Enlarging hands and feet for 4–5 yr.; acromegalic features; sella enlarged; B.M.R. plus 40%; visual fields normal	Acidophilic	Nov. 1934, 1,200 r (air) to each of 5 portals in 22 days.	In 3 mo. hands and feet felt smaller and patient felt better; 57 mo. later B.M.R. plus 14%; facial expression unchanged	140 mo. Excellent
8	C.E.C. First series	30	M	Failing vision to shadow perception os for 18 yr.; 42 lb. increase in weight; sella enlarged; vos blind; vod temporal field loss	Chromophobe	Partial surgical removal 2 yr. before irradiation. May 1931–May 1932, 4,000 r (air) with 200 kv. 0.5 mm. Cu., 1.0 mm. Al, and 5,400 r (air), 130 kv. 0.25 mm. Cu, 1.0 mm. Al	Improved following operation but blind 2 yr. after irradiation; field larger; 115 mo. vision showed no improvement.	160 mo. Good
9	W.E.D. Second series	22	M	Failing vision for 6 yr.; bitemporal cuts; od almost blind; enlarged sella	Chromophobe	May 1942, 8,000 r in 23 days. Tumor dose 3,217 r	Died 1 mo. after irradiation. Operation showed large tumor arising from sella. Increased intracranial pressure; 280 mm. water; contents removed; no pathology	1 mo. Poor
10	M. D. First series	70	F	Blurred vision for 3 yr. occipital headaches; enlarged sella; bitemporal hemianopsia	Chromophobe	May 1939, 1,516 r in 13 days. Nov. 1939, 1,766 r in 17 days. Total: 3,284 r in 6 mo.	Divided dosage because of age. 3 mo. after second course visual acuity improved. Fields unchanged; 21 mo. after first course able to write but vision not improved. Later follow-up, gradually failing vision	84 mo. Good
11	L. E. Second series	58	F	Enlarged sella; bitemporal cuts	Chromophobe	Feb. 1941, 9,000 r in 28 days. Tumor dose 3,672 r	Questionable improvement. Died with pituitary adenoma in June 1946. At postmortem tumor showed no evidence of having been irradiated	65 mo. Poor

TABLE I—(*continued*)

No.	Name	Age	Sex	Signs and Symptoms	Tumor Type	Treatment	Progress	Months Followed Result
12	B. F. Second series	49	F	Bilateral optic atrophy; od blind; os complete temporal cuts	Chromophobe	Sept. 1940, 9,000 r 27 days. Tumor dose 3,619 r	Some improvement in sight	68 mo. Excellent
13	G. F. Second series	68	M	Enlarged sella; bitemporal cuts; od almost blind	Chromophobe	June, 1943, 8,000 r in 24 days. Tumor dose 2,606 r	Increase in fields; os, od practically blind	35 mo. Good
14	V.M.E. Second series	35	M	Bitemporal cuts for 23 yr.; enlarged sella	Chromophobe	Oct. 1941, 8,000 r in 24 days. Tumor dose 3,397 r	Loss of headaches. Good vision od; drives car	55 mo. Excellent
15	L. G. Second series	22	F	Amenorrhea for 2 yr.; acromegaly; loss of vision over 2–3 yr.; optic atrophy on right; enlarged sella	Acidophilic	Nov. 7—Dec. 7, 1940, 3,420 r in 27 days, tumor dose	Visual fields returned to practically normal on the right; left eye still blind	76 mo. Excellent
16	G. H. First series	46	M	Blind od 21 mo.; failing vision os 3 mo. mentally dull; B.M.R. minus 31%; sella enlarged	Chromophobe	Aug. 1934, 1618 r in 13 days. Nov. 1939, 1766 r in 17 days. Total: 3,284 r in 6 mo., tumor dose	Visual fields os smaller after first course. Visual fields os larger 6 mo. later. B.M.R. minus 24%. Improved for 19 mo. At 52 mo. died suddenly. Autopsy showed 2×4 cm. sellar tumor	52 mo. Poor
17	V. H. Second series	70	F	Headaches; loss of vision; enlarged and eroded sella	Chromophobe	April 1944, 2,540 r in 28 days, tumor dose	Could read and write in 2 mo.	2 mo. Excellent
18	R. H. First series	50	M	Failing vision os 12 mo. failing vision od 3 mo. bitemporal hemianopsia; enlarged sella	Chromophobe.	Oct. 1939, 2,990 r in 37 days, tumor dose	3 mo. after therapy vision improved; 15 mo. still further improvement. 54 mo. died of pneumonia	54 mo. Excellent
19	H. H. First series	62	F	Blurred vision and dizziness for 3 yr.; coarse hands and feet; visual fields contracted; heart failure	Acidophilic	Oct. 1932, 3,222 r in 23 days, tumor dose	Died 1 mo. after therapy	1 mo. Poor
20	E. J. First series	28	F	Weight increase of 130 lb. in 10 yr.; enlarged sella; no visual disturbance; frequent headaches	Chromophobe	March 1934, 1000 r in (air) to each temporal area. Sept. 1934, repeated above	Headaches relieved for 81 mo. after first course. No weight gain	144 mo. Excellent
21	T. J. Second series	30	F	Acromegaly; back pain; binasal field cuts; headaches	Acidophilic	June 1942, 8,000 r in 25 days. Tumor dose 2,480 r	Loss of headaches. Increased constriction of fields. Decrease in fields made operation imperative. Found hemorrhagic cyst. Practically all removed. Recurrence probably prevented	47 mo. Poor for roentgen irradiation. Good surgically
22	J. K. First series	68	M	Failing vision for 5 yr.; headaches; bitemporal hemianopsia; enlarged sella	Chromophobe	Sept. 1936, 3,148 r in 23 days. Further treatment elsewhere 1937–1938, amount unknown	42 mo. after treatment, no headaches; vision fair. Died of cerebral accident	42 mo. Good
23	L. K. First series	35	M	Failing vision and headaches for 18 mo.; complete temporal hemianopsia os; clinoids thin	Chromophobe	Oct. 1939, 3,043 r in 48 days	Visual acuity improved; fields unchanged; headaches improved. Good result in 23 mo.	81 mo. Excellent

TABLE I—(*continued*)

No.	Name	Age	Sex	Signs and Symptoms	Tumor Type	Treatment	Progress	Months Followed Result
24	M. L. Second series	21	F	Acromegaly and gigantism; loss of temporal cuts	Acidophilic	April 1941, 9,000 r in air air in 27 days	Vision normal; generally good health	61 mo. Excellent
25	A. L. Second series	60	F	Acromegaly	Acidophilic cystic	May 1941, operated on—60 cc. of fluid aspirated with drainage of frontal lobe. 9,000 r in 27 days. Tumor dose 3,700 r	Operated on after irradiation. Died three days later. No autopsy	1 mo. Poor
26	E. L. Second series	30	M	Acromegaly; headaches; enlarged sella; no visual field changes	Acidophilic	Sept. 1944, 3,080 r in 23 days, tumor dose	Loss of headaches; general good health	11 mo. Good
27	B. L. Second series	19	F	Amenorrhea; hirsutism; hypertension	Basophilic	Aug. 1942, 2,157 r in 15 days, tumor dose	Seemingly improved for 1 week; sudden death with low blood pressure	1 wk. Poor
28	F. L. First series	48	F	Failing vision for 3 yr.; headaches; ptosis of right lid; enlarged sella; fields contracted	Chromophobe	Jan. 1939, 1,899 r in 21 days, tumor dose	Died 4 mo. after treatment; improvement in ptosis but developed mental confusion	4 mo. Poor
29	L. M. Second series	59	F	Acromegaly; trigeminal neuralgia; not much field cuts	Acidophilic	March, 1943, 8,000 r in 23 days. Tumor dose 2,485 r	Vision good	38 mo. Excellent
30	B. M. First series	36	F	Increasing weight for 13 yr.; headaches; enlarged sella; temporal field cut	Chromophobe	Dec. 1931, 819 r in 7 days, tumor dose	Good vision. Eyes weak unable to see to thread needle	108 mo. Excellent
31	M. M. Second series	41	M	Poor vision for 6 yr.; headaches; loss of vision greater in left eye than right	Chromophobe	April 1942, 8,000 r in 23 days. Tumor dose 3,355 r	Od same	94 mo. Good
32	O. M. Second series	36	F	Decreased visual fields; headaches; syphilis-meningovascular	Chromophobe	Sept. 1941, 8,000 r in 23 days	Increase in fields	51 mo. Excellent
33	J. P. First series	11	M	Increasing obesity for 3 yr.; headaches; sleepiness; right homonymous hemianopsia	Chromophobe	Sept. 1937, 2,866 r in 29 days, tumor dose	Rapid improvement in vision; loss of weight and gain in height; no headaches; with original class in school	108 mo. Excellent
34	J. H. P. First series	30	M	Headaches; failing vision; bitemporal hemianopsia; enlarged sella	Chromophobe	June 1936, 2,576 r in 25 days, tumor dose	Fields normal in 3 mo.	114 mo. Excellent
35	R. P. Second series	34	M	Acromegaly; bitemporal cuts; increase in size of hands, feet and head	Acidophilic	Aug. 1943, 8,000 r in 25 days. Tumor dose 2,620 r	Increased fields. Works normally	33 mo. Excellent
36	G. R. Second series	22	F	Amenorrhea; bitemporal hemianopsia	Chromophobe	Oct. 1943, 8,000 r in 23 days. Tumor dose 2,520 r	Slight improvement after nearly 2 yr.	32 mo. Excellent
37	C. R. First series	35	M	Headaches and blurred vision for 1 yr.; bitemporal hemianopsia; enlarged sella	Chromophobe	June 1935, 1,706 r in 16 days, tumor dose Jan. 1936, 2,152 r in 18 days, tumor dose	Gradual improvement in vision until 6 mo. post-irradiation, it was normal	132 mo. Excellent
38	C. R. First series	44	M	Bitemporal hemianopsia for 1 yr.; headaches	Chromophobe	Oct. 1937, 2,510 r in 25 days, tumor dose	Loss of headaches; vision slightly but definitely improved	104 mo. Excellent

TABLE I—(*continued*)

No.	Name	Age	Sex	Signs and Symptoms	Tumor Type	Treatment	Progress	Months Followed Result
49	P. R. Second series	15	M	Pituitary dwarf with sellar changes and field cuts; enlarged sella	Chromophobe	Oct. 1941, 8,000 r in 23 days. Tumor dose 2,640 r	Restoration of field cuts. Also received pituitary growth hormone	55 mo. Excellent
40	R. S. First series	39	M	Failing vision for 2 yr.; almost blind os for 1 yr.; headaches for 1 yr.; bitemporal hemianopsia; enlarged sella	Chromophobe	Jan. 1938, 2,047 r in 29 days, tumor dose May 1939, cystic tumor partially removed	Visual fields improved postoperatively	96 mo. Poor
41	A. S. First series	46	F	Blurred vision and headaches for 5 yr.; vos 6/6–1; temporal hemianopsia os; unable to obtain field od; enlarged sella	Chromophobe	April 1933, 3,120 r in 12 days, tumor dose	Loss of headaches and gradual improvement in vision. Glasses needed only for reading	156 mo. Excellent
42	L. S. Second series	48	M	Failing vision for 6 mo. Enlarged sella	Chromophobe	May 1943, 8,000 r in air in 24 days	Gradually became blind; paralysis agitans	37 mo. Poor
43	V. S. First series	58	F	Bitemporal hemianopsia; enlarged sella	Chromophobe	Nov. 1936, 2,129 r in 34 days, tumor dose	Slightly enlarged fields	116 mo. Excellent
44	J. T. First series	57	M	Failing vision; diplopia for 3 yr.; vod 6/24; vos counts fingers at 2 ft.; enlarged sella	Chromophobe	Jan. 1933, 3,820 r in 34 days, tumor dose	At 74 mo. patient "saw large print at 5 ft." At 8 yr. vision worse. At 160 mo. LMD stated patient's vision good	160 mo. Excellent
45	A. T. First series	35	F	Failing vision for 1½ yr.; amenorrhea 6 yr.; bitemporal hemianopsia; enlarged sella	Chromophobe cystic	July 1937, 3,337 r in 27 days, tumor dose. Nov. 1937, cystic tumor removed surgically	Worse after irradiation; much improved 37 mo. postoperatively	41 mo. Poor
46	G. T. Second series	28	F	Acromegaly, changed facial expression; large hands and feet; amenorrhea for 3 yr.; facial neuralgia	Acidophilic	May, 1942, 8,000 r in 27 days. Tumor dose 3,397 r	Fields improved, then decreased. Can sew and do housework; facial pains	46 mo. Poor
47	L. W. Second series	56	F	Painless failing vision for 4 yr.; bitemporal hemianopsia	Chromophobe	April 1942, 8,000 r in 24 days. Tumor dose 2,472 r	Od better; os worse. Cataracts, but otherwise all right	49 mo. Good
48	H. W. Second series	63	F	Bitemporal hemianopsia	Chromo phobe	Oct. 1940, 8,600 r in 25 days. Tumor dose 2,660 r	Vision and fields better; then constricted; operated 6 mo. post-irradiation; large pituitary adenoma found; chromophobe; scarring due apparently to x-ray; general condition good	66 mo. Poor
49	F. Y. First series	54	M	Diplopia for 4 mo.; ptosis for 2 mo.; lesion of 3rd and 4th cranial nerves; ophthalmoplegia; markedly enlarged sella; visual fields contracted	Chromophobe	March 1932, 4,277 r in 23 days, tumor dose	Fields normal in 1 yr.; post-irradiation recalcification of sella in its enlarged form; 8 yr., and 9 mo. after treatment visual fields normal	170 mo. Excellent
50	I. Z. Second series	64	F	Headaches; erosion of sella; visual fields constricted	Chromophobe	Oct. 1946, 2,385 r in 23 days, tumor dose	Loss of headaches; increased visual fields	9 mo. Excellent

irradiation. The relationship was not clear, however.

Mental Deterioration. In our report of 1941, on the treatment of 25 cases of pituitary adenomas, Cooper and I expressed the thought that in a patient with hypertension we may have caused mental deterioration through a combination of vascular and radiation damage. Even before treatment, however, this patient had had vomiting, numbness of the left ear and loss of hearing on the same side. In discussing the paper, Sosman disagreed with our conclusion on the point and voiced the conviction that with our dosage (which was higher then than now) we could not have caused cerebral damage. Along this line I have 4 more cases that I wish to discuss briefly. Two patients with symptoms of pituitary tumor were sent to us for treatment from psychopathic hospitals. In each instance there was some increased mental lucidity and questionable improvement of vision immediately following treatment. A short time later, however, both patients relapsed into their former states of psychosis. The results have been considered poor although it is obvious that there was not much of a chance for a good result to begin with. They are not included in the reported series. A third patient (K. S.), aged fifty-one, was sent to us diagnosed as a case of chromophobic adenoma with optic atrophy and almost complete blindness. Six months following a full course of treatment, she was still blind and merely vegetative. The fourth case (V. B.) is one regarding which I am uncertain. The diagnosis had been missed on this patient for fourteen years and when we saw her, she had a spastic paraplegia, bitemporal hemianopsia and cardiac enlargement. She was given a tumor dose of 2,690 roentgens in the usual way and subjectively was much improved, both in general and as regards her vision. Eight days later, however, she became confused and complained of headaches. Symptoms suggested internal hydrocephalus and the spinal fluid pressure was 270 mm. Her temperature reached 105° F. before it subsided. She died six days later.

The whole question of damage following irradiation for pituitary adenomas seems to be bound up with the sequential factor. If treatment has been given and cerebral symptoms ensue, we (and particularly the referring department and our other medical friends) are likely to explain all phenomena as caused by the treatment. That this is not fair, we will all agree but it is difficult to avoid. These symptoms are not seen in cases of intensive irradiation of brain tumors, where more treatment is given. Also in 2 cases to whom we gave intensive irradiation for pituitary tumor who finally came to autopsy, there was no histopathologic evidence of damage to the vascular structures nor to the glial tissue. Although I am not convinced that we do not cause some damage at times, we still have no definite proof that we do. Age, sex, dosage, duration of symptoms, type of tumor, etc., seemed to have no bearing on this reaction.

Three of our cases are of considerable interest because they died and came to autopsy. The first case (R. H.) was a male, aged fifty, who was given a tumor dose of 2,990 roentgens for a chromophobic adenoma of the pituitary in September, 1939. He had bitemporal visual field cuts and an enlarged sella with headaches. During the treatment, he had further constriction of the fields but within a month he had shown great improvement. From that time on his vision improved and his headaches disappeared. In March, 1944, the patient entered the University Hospitals with pneumonia and died. Autopsy showed the pituitary fossa filled with a thick creamy hemorrhagic material which apparently represented degenerated pituitary tumor. The interesting feature was the microscopic examination which showed compressed but normal pituitary tissue. Adjacent to it and apparently causing the pressure was adenomatous tissue which showed no signs of having been irradiated.

The second case was a woman, aged

sixty-four, on whom a diagnosis of chromophobic adenoma was made and 2,660 roentgens given to the pituitary. She had some immediate response in the form of increased visual fields but there was further constriction at the end of six months and she was operated on. A tumor was found lying largely above the sella and displacing the chiasm upward and the optic nerves outward. The tumor was solid but the contents were evacuated and part of the capsule was removed. Microscopically the tumor was highly cellular and appeared viable.

The third case was a woman, aged fifty-eight, whose pituitary was given 3,672 roentgens on the basis of a diagnosis of chromophobic adenoma in February, 1941. For twenty-nine months she was in good condition and she had had improvement in her vision up to 6/6-1 in her left eye. The right had been practically blind for about a year before coming to the hospital. After more than five years following irradiation she became bedridden and was re-admitted to the hospital where she died in about two weeks with all the signs of hypothalamic irritation. At autopsy, a tumor of the pituitary, 2 cm. in diameter, was found with erosion of the posterior clinoids and pressure posteriorly. The neurologist and the pathologist considered that she had died primarily of the pituitary tumor. Microscopically, the mass was composed of apparently normal and viable tumor cells. This is the only case we have found who did well for such a long time and then relapsed.

I find it difficult to explain why some pituitary adenomas respond well to relatively small doses of radiation and why others resist large doses, but as radiologists, we are accustomed to see this in other types of neoplasm, for example, carcinoma of the lip and cervix. We accept this as being due to the radiosensitivity or radioresistance of the tissue, whatever that may mean. I find it more difficult, however, to explain why a tumor that has been irradiated and obviously influenced by the treatment (because the patient has been symptom free for years) still shows no microscopic evidence of having been treated but continues to appear entirely viable unless it be loss of turgescence and swelling.

The follow-up of the cases treated at least six years ago showed no case of excellent or good result that retrogressed and one reported as poor at ninety-six months has now an excellent result at 161 months. The case observed longest with an excellent result was seen first in March, 1932. In general, therefore, it seems fair to assume that satisfactory results are permanent although we have seen one exception to that statement.

SUMMARY

1. Review of results of irradiation of a series of twenty-four cases of pituitary tumors studied six years ago indicates that they are permanent.

2. A review of a series of fifty cases emphasizes that irradiation is a satisfactory primary method of treatment. The over-all good results are in the range of 70 per cent and the chromophobic tumors respond as well as the acidophilic.

3. It is important to follow the results of treatment carefully for at least two months, particularly regarding the visual fields. If there is diminution of the fields at that time, the neurosurgeon should be called in consultation because the tumor is either cystic or otherwise radioresistant.

4. Psychotic patients or patients with any previous cerebral symptoms will probably not do well and may have their symptoms exaggerated. It is questionable whether they should be irradiated.

5. Our experience indicates that there may possibly be occasional cerebral damage from irradiation although of this there is no proof. The evidence is sequential.

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DISCUSSION

DR. MERRILL C. SOSMAN, Boston, Mass. I think we can all agree with everything that Dr. Kerr has presented this morning, and agree with his conclusions that irradiation has a beneficial effect on the majority of pituitary adenomas.

I would like to point out that this is a long-range project. A five year survival means nothing in this type of patient with this type of tumor, as it does in the malignant tumors we are more accustomed to dealing with. It is really a long-range project, and I hope that Dr. Kerr will again present these same patients and their follow-up ten years from now, with additional cases that may accumulate in the meantime.

There are three points that I want to emphasize. One is that I think we can say there is conclusive proof that irradiation has a beneficial effect on 70 to 80 per cent of the pituitary adenomas, and that the beneficial effect persists in the great majority of those so treated.

Second, that roentgen therapy, particularly in the earlier days, was not without danger and damage. When I started in 1922, we were using low voltage technique, a rather thin filter, and we customarily gave repeated doses several weeks or months apart in following these patients. We have found 7 or 8 cases of what Dr. Camp called "irradiation necrosis" of the bone in patients coming back fifteen or twenty years after the original treatments were given. I shall show you an example of one of those patients.

The exact dose to be given and the exact method of giving it is still subject to discussion. I am inclined to believe from the evidence presented that Dr. Kerr has a much better method at present than we had twenty-five years ago. We have gradually been moving toward the same conclusion that Dr. Kerr has reached.

There is one thing we must avoid, which is a very common failing among radiologists: the conclusion that if a certain dose gives a good result, an increased dose must necessarily give a better result. That is an entirely erroneous conclusion, and I am afraid it is a form of wishful thinking which is all too prevalent in our profession. I have been guilty of the same sort of erroneous deduction myself.

The third thing is that these tumors often

spontaneously tend toward a burned-out stage of hypopituitarism, particularly the acidophilic tumor. The end stage of hypopituitarism has been rather hopeless, as far as treatment goes, up to the present time. The patient appears quite similar to a patient with myxedema: sluggish, somnolent, with very little activity, but thyroid even in large doses has no effect on these patients with hypopituitarism. Dr. Thorn at our hospital has been using adreno-corticotropic hormone, extracted from pituitary glands (A.C.T.H.) which alleviates many of these symptoms if the patient's adrenal glands are intact.

(Dr. Sosman then showed several slides, first illustrating the skin atrophy and telangiectasia in the temporal areas which resulted from the earlier low voltage irradiation, and the underlying mottled absorption of the temporal bones which increased in extent and degree as the years elapsed. Then he showed tables and charts of Dr. Thorn's work in replacement therapy of pituitary deficiency by the adreno-corticotropic hormone (A.C.T.H.) The details will be found in the Holmes Lecture and in the Caldwell Lecture which are to appear later in this JOURNAL.)

In conclusion, I would like to congratulate Dr. Kerr on his excellent presentation and hope that he will follow this group of patients as long as he can. When patients have relatively benign tumors such as pituitary adenomas, it is often a question whether or not the doctor will survive his patient.

THE GASTROSCOPIC PICTURE IN POST-IRRADIATION GASTRITIS*

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BRICK[1] in 1946 described the new post-therapeutic clinical entity of chronic gastritis following massive irradiation to the upper abdomen. He has presented data on the clinical, roentgenographic, and pathologic aspects of post-irradiation gastritis in a series of soldiers who had been treated for metastatic malignancy.[1,2]

The present communication deals with the gastroscopic picture presented by the group of patients from which Brick drew his material. Since other aspects of post-irradiation gastritis have already been adequately described by Brick, an attempt has been made to include here only material which has a direct bearing on the gastroscopic findings.

MATERIALS AND METHODS

The 12 patients considered were soldiers who had been diagnosed and treated for malignant conditions while in the service. All were white males, aged twenty to thirty-three. The diagnosis in each case had been made by histopathologic study. One had a retroperitoneal reticulum cell sarcoma, 4 had seminoma of the testis, 3 had malignant teratoma of the testis, and 4 had embryonal carcinoma of the testis. Surgical procedures in various patients had included orchidectomy, radical parailiac and paraaortic node resection, exploratory laparotomy, and gastric resection, the last for perforation and hemorrhage complicating post-irradiation gastritis.

Radiation therapy had been given with the 1,000 kilovolt machine through five portals which had been constant in size and position in all patients.† The gastric area was involved by two of these portals: a 10 by 10 cm. epigastric portal, the inferior border of which had been placed 25 cm. above the base of the penis, and a 10 by 15 cm. lumbodorsal portal along the long axis of the spine and centered over the second lumbar vertebra. The radiation doses given here are expressed in terms of skin dosage.

The gastroscopic examinations were made by one observer. The Cameron-Schindler omniangle instrument was used. Pre-examination medication consisted of a retention enema of 0.4 gm. nembutal one to two hours beforehand and atropine 0.0008 gm. subcutaneously one-half to one hour beforehand.

The gastroscopic findings described below are taken directly from the original reports. To save space, references to the normal appearing portions of the stomach and statements of negative findings are for the most part omitted. In each case, at least the proximal half of the stomach—the part which was outside of the field of radiation—was normal, and in many only the distal third showed pathologic changes. In no case did preliminary drainage of the stomach bring up a significant amount of blood; in 10 of the 26 drainages the fasting contents contained free acid.

In the cases of those patients who came to gastric resection, the pathologic pictures presented by the resected specimens are outlined. The findings at upper gastrointestinal roentgenography are also presented when they were done within thirty days of gastroscopy.

CASE PRESENTATIONS

In the presentations below, the date of each examination is expressed in terms of

† Physical factors: 1,000 kv. Total filtration 3 W., half-value layer, 3.6 mm. Pb., 3 ma., 70 cm. distance, 80 r per minute, measured in air.

* Grateful appreciation is extended to the Photographic Laboratory, Walter Reed General Hospital, for the reproductions of the illustrations.

days following the last day of radiation treatment.

Case I. Twenty-nine years old. Seminoma of the testis. Treatment: 12,600 roentgens over a thirty day period; 2,400 r to epigastric portal and 2,400 r to lumbodorsal portal.

Gastroscopy, thirty-six days: "The whole pars media shows paleness and increased translucency, plus total absence of rugae, suggestive of edema. The fundus is normal without abnormal mucosal or rugal change. The antral configuration is normal, but this portion distends poorly with air, and its walls, although of normal color, appear thickened. The pylorus is well visualized and is seen to close regularly with shallow antral peristalsis; there is no bile reflux. On the greater curvature of the antrum, just distal to the anterior end of the angulus, there is a rather deep, clean, elliptical ulcer three rugal widths in length and two rugal widths in breadth. The long axis of the ulcer runs obliquely anteroposteriorly. The base is gray, homogeneous and clean. There is no exudate or bleeding, and the margins show almost no inflammatory reaction. There is no nodularity."

Gastrointestinal roentgen series, forty-two days: Normal, with normal mucosal pattern, except for narrowing of the antrum.

Gastrointestinal roentgen series, sixty-two days: Normal.

Gastroscopy, seventy-nine days: "The ulcer previously seen is now almost circular in outline. It is likely that this change in shape is due to healing, for there appears to have been some reduction in size. Again it is noted that there is practically no inflammatory reaction of the ulcer margin and no contraction or other evidence of fibrotic change at its base. The base is gray and clean and there is no exudate, bleeding or nodularity. Its depth is still as great as its width. The pylorus is normal anatomically and functionally, but antral peristalsis is shallow and infrequent. At this time there is no edema or apparent infiltration of the distal portion of the stomach. The rugae of the greater curvature now appear normal, and they pass by the ulcer site without distortion."

Gastroscopy, ninety-five days: "The appearance of the ulcer has changed, but its size probably has not. At this time there is evidence of inflammatory reaction at the periphery with a narrow margin of intense hyperemia and edema. These changes probably account for the apparent increase in the ulcer's depth. An interesting picture is presented in that the rugae pass by the ulcer without distortion. Although peristalsis is minimal, there is no sense of generalized infiltration of the walls of the distal stomach. Pylorus is normal."

Gastroscopy, 143 days: "The site of the former ulcer is now occupied by a small white circular scar; there is no evidence of contracture at the scar and the paths of the rugae of the region are not distorted. Again there is no impression of rigidity or infiltration of the gastric walls. The peristalses at this time are unimpeded, and the antrum and pylorus are normal anatomically and functionally. There is much thick, yellow-gray mucus on the posterior wall."

Gastroscopy, 209 days: "The scar is now almost indistinguishable from the surrounding mucosa, showing only a pink saucerization. The rugae of the region are not distorted or deformed. There is no functional impairment. This is an essentially normal stomach."

Case II. Thirty years old. Embryonal carcinoma of testis. Treatment: 25,800 roentgens over seventy-five day period; 5,400 r to epigastric portal and 4,800 r to lumbodorsal portal.

Gastroscopy, 192 days: "The pylorus is well visualized and is seen to function normally, responding to regular antral peristalses. The antrum shows no rigidity and dilates easily on inflation. The rugae everywhere are normal and iron out well. There are no evidences of infiltration of the stomach wall, and no generalized mucosal abnormalities are present. The mucous lake is largely bile. On the greater curvature of the antrum, midway between the pylorus and the angulus, there is a clean, punched-out, rather deep elliptical ulcer. The ulcer runs obliquely anteroposteriorly across the greater curvature. Its length is equal to about four rugal widths and its breadth to about two. The base is gray and clean without exudate, bleeding or nodularity. The periphery of the ulcer shows no hyperemia or infiltration. The mucosa is normal up to the crater margin. There is only a minimal suggestion of contracture of the site as judged by mucosal radiations. The rest of the stomach appears normal in all respects."

Case III. Twenty-six years old. Malignant teratoma of testis. Treatment: 23,900 roentgens over forty-nine day period; 4,800 r to epigastric and 4,800 r to lumbodorsal portals.

Gastroscopy, 197 days (Fig. 1): "The mucosa

is pale. There is a bubbling bile reflux through the constantly patulous pylorus. The antrum is tubular and distorted, and cannot be distended by inflation. Its configuration is such that the entire circumference is visualized. The distal half of the pars media is stiff. The entire distal half of the stomach shows marked generalized submucosal infiltration which apparently is responsible for the stiffness, distortion and failure of the antrum to inflate. Rugae here are absent. The mucosa of the region is more



FIG. 2. CASE V. Two hundred and thirty-nine days after completion of radiation therapy.

than usually translucent, with increased highlights. There is no ulceration, erosion, petechia, free blood, or atrophic or hypertrophic gastritic change. The proximal half of the stomach is normal."

CASE IV. Thirty-three years old. Seminoma of testis. Treatment: 24,700 roentgens over seventy-six period; 4,900 r to umbilical portal and 5,000 r to lumbodorsal portal.

Gastrointestinal roentgen series, 276 days: There is narrowing and fixation of the prepyloric area. The stomach is inactive.

Gastroscopy, 284 days: "The motility of the distal half of the stomach is markedly impaired and peristalsis was not observed in the antrum over a period of several minutes. The antrum shows marked submucosal infiltration which gives this region a tubular appearance; the angulus is involved in the process and is not prominent. The pylorus appears normal but remains in a partially contracted state, and was not seen to relax or to close during the examination. There is a small amount of bile regurgitation. The mucosa everywhere is intact without ulceration. There are many superficial petechiae scattered over the greater curvature of the distal pars media."

CASE V. Twenty years old. Embryonal carcinoma of the testis. Treatment: 24,000 roentgens over sixty-one day period; 4,800 r to epigastric portal and 4,800 r to lumbodorsal portal.

Gastrointestinal roentgen series, 133 days: "There is a deep crater on the anterior wall. The mucosa and peristalsis are normal except for the area of the ulcer."

Gastroscopy, 147 days: "The distal third of the stomach is a stiff contracted tube lined with closely pressed rugae which cannot be effaced because the region fails to distend on inflation. No peristalsis is seen. The pylorus is not visualized. On the mid-anterior wall of the pars media there is a deep elliptical ulcer, estimated to be 2.5 by 1 cm. in diameter. The floor is covered by a dirty gray membrane and the edges are a little elevated. There is no hyperemia, bleeding, nodularity or contracture at the site."

Gastroscopy, 238 days: "Examination is rather unsatisfactory because of rapid passage of air through the stiff fixed tubular antrum. The pylorus is not seen but is presumed to be constantly patulous because of the quick deflation and collapse of the proximal stomach. The region of the angulus at this time appears normal, the infiltration now being limited to the antrum. There is considerable thick, gray mucus scattered about. No ulceration, scar or other localized mucosal lesion is seen."

Gastrointestinal roentgen series, 239 days (Fig. 2): "The stomach is small and shortened on its lesser curvature side. The antral mucosa is denuded. The antrum is rigid, decreased in caliber and fixed. There is an ulcer 2 cm. in diameter on the posterior wall of the antrum. The pylorus is open. Peristalsis is extremely sluggish."

Gastroscopy, 293 days: "Although peristalsis is very weak and infrequent through the antrum, the pylorus is now normal both anatomically and functionally. The antrum is narrow and distorted, pointing inferiorly and



FIG. 1. Case III. One hundred and ninety-seven days after completion of radiation therapy. Tubular distortion of antrum by submucosal infiltration, allowing visualization of all sides. Absence of rugae. Fixed patulous pylorus with bile reflux.



FIG. 4. Case VIII. Six hundred and eighteen days after radiation therapy. Thick yellow-gray mucus. "Tight" angulus. Submucosal infiltration.



FIG. 3. Case VII. Five hundred and seventy-one days after radiation therapy. Tubular infiltrated antrum. "Tight" angulus. Large petechiae.

posteriorly. On the lesser curvature of the antrum there is a punched-out circular ulcer, about four rugal widths in diameter. The base is gray and clean without bleeding or exudate. The periphery is involved in a mild generalized hyperemia which is seen in the mucosa of most of the distal half of the stomach. On the anterior wall of the pars media and on the lesser curvature just proximal to the angulus there are small superficial erosions which are not bleeding. Scattered about the antrum and distal pars media there are about ten minute flame-shaped petechiae. No evidence of the previously seen anterior wall ulcer is found."

Gastrointestinal roentgen series, 297 days: "Distal half of the stomach is rigid with markedly decreased caliber. It is shortened at its lesser curvature. Peristalsis is sluggish. There is an ulcer 2 cm. in diameter on the posterior wall of the proximal antrum on the lesser curvature side."

Gastroscopy, 353 days: "The antrum points posteriorly but, although distorted, it appears normal in circumference and dilates satisfactorily on inflation. The pylorus appears normal as does antral peristalsis. The lesser antral curvature cannot be seen and no opinion can be given regarding the site of the previously described antral ulcer. The anterior wall of the pars media is satisfactorily visualized and there is no residual change to demarcate the site of the large ulcer formerly found in this area. There are three small pigmented spots in the greater curvature of the pre-antral region, but no petechiae or erosions."

Case vi. Thirty-three years old. Reticulum cell sarcoma, retroperitoneal. Treatment: 7,400 roentgens over fifty-five day period; 3,600 r to epigastric portal and 3,800 r to lumbodorsal portal.

Gastrointestinal roentgen series, 327 days: "There is hypomotility of the distal half of the stomach and hypertrophy of the rugae."

Gastroscopy, 329 days: "The interior configuration of the stomach and the consistency of the gastric walls are normal. There is no evidence of fixation, infiltration or generalized mucosal change. The pylorus is normal anatomically, but remained patulous without closing while under visualization for several minutes. The mucosa everywhere is normal except for a shiny white circular scar 1 by 1 cm. at the middle of the angulus margin."

Gastroscopy 336 days after therapy was normal except for the persistent patulousness of the pylorus and the previously described scar on the angulus.

Gastroscopy 377 days after therapy showed no change. The infrequency of antral peristalsis was notable, as was the constant bile reflux.

Case vii. Twenty-nine years old. Embryonal carcinoma of the testis. Treatment: 15,000 roentgens over ninety-eight day period; 5,400 r to epigastric portal and 4,800 r to lumbodorsal portal.

Gastroscopy, 571 days (Fig. 3): "Preliminary drainage of the stomach brought up about 300 cc. of poorly digested food from the previous day. In spite of lavage, a large portion of the fundus was obscured by retained material. The antrum is tubular and narrow with heavy submucosal infiltration. Although the infiltration seems to stop distal to the angulus, the latter appears 'tight' and does not expand on inflation of the stomach. The angulus is, however, thin with normal appearing mucosa. The pylorus was not well seen. There is no bile reflux. Scattered over the pre-antral region are many dark red petechiae of varying size, the largest being about two rugal widths in diameter. Among the petechiae there are a few dark brown pigmented spots. The mucosa elsewhere is normal but pale, without ulceration or erosion."

Gastroscopy, 585 days: "There was a moderately large mucous lake, but except for this area and the pylorus, all levels were well visualized. The interior configuration of the antrum is considerably distorted, with narrowing and fixation. The pylorus again remained obscured by the 'tight' angulus. The infiltration through the antrum is marked. No peristaltic motion whatever is seen. The petechiae and pigment spots appear as before. No bile reflux. No ulceration."

Case viii. Twenty-eight years old. Seminoma of testis. Treatment: 25,000 roentgens over fifty-three day period; 5,000 r to epigastric portal and 5,000 r to lumbodorsal portal.

Gastrointestinal roentgen series, 603 days: "The stomach is small and shortened on its lesser curvature. The antrum is constricted, canalized and fixed. The mucosa of the corpus and antrum is atrophic. The pylorus is open."

Gastroscopy, 613 days: "The examination is not satisfactory because most of the mucosa is obscured by a rather uniform coating of thin, yellow-gray mucus. The antrum is decreased in

caliber and so fixed that it could not be at all dilated by inflation. No peristalsis is noted in the stomach. The pylorus was constantly obscured by the angulus. Because of the mucus, no opinion can be given regarding the appearance of the mucosa."

Gastroscopy, 618 days (Fig. 4): "All levels were well visualized except for the distal antrum which remained in the shadow of the 'tight' angulus and a portion of the fundus which was obscured by a rather large bile lake. No peristaltic motion was seen in the stomach. At this time there are only a few patches of yellow-gray mucus scattered about. The antrum is decreased in diameter and appears thickly infiltrated, failing to expand on inflation. The rest of the mucosa is normal. On the posterior wall of the pars media close to the greater curvature there is a small bulge without distortion of the rugae; this gives the impression of an extrinsic mass pressing on the stomach wall."

Gastroscopy, 633 days: "The pylorus again is not visualized but its patency is assured by the constant reflux of frothy bile. No peristalsis is seen. The antrum is rigid and tubular, showing infiltration of its walls. The mucosa everywhere is intact and of normal color. Proximal to the antrum there is no infiltration or fixation."



FIG. 5. Case IX. Ninety-one days after radiation therapy.

CASE IX. Twenty-two years old. Malignant teratoma of the testis. Treatment: 24,000 roentgens over fifty-four day period; 4,800 r to epigastric portal and 4,800 r to lumbodorsal portal.

Gastrointestinal roentgen series, ninety-one days (Fig. 5): "The stomach is contracted and shows a bulge on the greater curvature of the antrum which simulates an ulcer. The stomach is rigid and there is no peristalsis. The mucosa is granular and hypertrophied."

Gastroscopy, ninety-nine days: "The greater curvature of the antrum is obscured by regurgitated bile, but the examination is otherwise satisfactory. The antrum is stiff and elongated, and no motion is seen in the region, either as result of peristalsis or inflation of the stomach. The pylorus is well seen at the end of the tubular antrum and remains patulous. There is intermittent bile reflux. The submucosal infiltration stops about 1 cm. proximal to the angulus, the transition to normal thin mucosa being rather abrupt. The angulus is blunt and heavy. No mucosal lesion per se is found."

Gastrectomy, 224 days. Pathologic report: "The mucosal surface is markedly edematous and hyperemic, with punctate hemorrhages scattered over the surface. The rugae are ironed out as the pylorus is approached, and 2.5 cm. from the pylorus is an irregular, ulcerated area, measuring 0.3–1.5 by 2–4 cm. The ulcer is up to 3 mm. deep. The base is gray-pink friable tissue, covered with fibrin. The serosal surface is somewhat dull and has a leathery feel. Microscopic: The base of the ulcer is covered by fibrinous exudate, beneath which is a narrow zone of granulation tissue infiltrated by a subacute inflammatory reaction. The edge of the ulcer shows gradual thinning of the mucosa and glands with a marked submucosal subacute inflammatory reaction. The submucosa shows rather severe interstitial edema, and there are focal areas of subacute inflammatory infiltrate in the serosa."

CASE X. Twenty-five years old. Malignant teratoma of the testis. Treatment: 26,000 roentgens over fifty-five day period; 5,200 r to epigastric portal and 5,200 r to lumbodorsal portal.

Gastroscopy, 130 days: "The antrum is directed superiorly and anteriorly, and probably not more than half its length is visualized. The angulus and musculus sphincter antri are large and thick with tightly stretched mucosa. This infiltration extends into the antrum as far as visualization can be carried, and the resulting

fixation seems responsible for the inability of the distal half of the stomach to expand on inflation."

Gastrointestinal roentgen series, 148 days (Fig. 6): "The antrum is narrow and the rugal pattern is distorted. The pylorus remained patent throughout the examination. The rugae everywhere are considerably hypertrophied."

Gastrectomy, 190 days. Pathologic report: "In the prepyloric region the stomach wall is 1.5 cm. thick. The serosal surface is smooth and glistening. The mucosa is greatly thickened and extremely edematous, as are the tissues beneath it. The convolutions are soft and velvety, showing petechial hemorrhages. In the pyloric canal there is an ulcer 1.8 by 1.7 cm. in diameter and 0.6 cm. deep. Microscopic: There is widespread edema with considerable loose submucosal fibrosis and associated marked chronic inflammation. The muscularis shows edema with areas of chronic inflammation. The mucosa shows marked metaplasia to an intestinal type of epithelium, with many glands lined by goblet cells. The glands are for the most part moderately atrophic. There is a mild increase in fibrous tissue between the glands. The ulcer surface is covered by fibrous tissue with deep fibrosis below the ulcer."

Gastroscopy, 355 days: "The distal portion of the stomach has been resected and now the interior configuration is almost spherical. The enterostomy stoma is close to the greater curvature and appears adequate in size. Very little of the jejunum is seen. The stomal margin appears healthy without ulceration. Several rugal crests are hyperemic, but, except for this, there is no erosion, infiltration, petechia, atrophy, hypertrophy or other abnormal mucosal change."

Case xi. Twenty-nine years old. Embryonal carcinoma of testis. Treatment: 13,000 roentgens; 5,500 r to epigastric portal and 5,500 r to lumbodorsal portal.

Gastroscopy, 150 days: "The usual 'tube-like' appearance is seen, constituting the distal third of the stomach. The angulus is apparently severely involved in this infiltration process and is not recognizable as such. Inflation does not change the appearance of the distal stomach. Air quickly passes through the presumably patulous pylorus, although the latter is not seen. When the stomach deflates and the lateral walls collapse around the objective, the antral lumen remains tubular and patent. No mucosal lesions are found."



Fig. 6. Case x. One hundred and forty-eight days after radiation therapy.

Gastrointestinal roentgen series, 166 days: "There is marked narrowing of the stomach extending from the lower portion of the pars media through the antrum. There is an ulcer crater measuring 2 by 5 mm. on the greater curvature 3 cm. proximal to the pylorus."

Gastrectomy, 190 days. Pathologic report: "The serosa is smooth except for a 3.5 by 1.3 cm. area with shaggy tags. The mucosa shows normal rugae over the proximal 2.5 cm. of the specimen, and here the wall is 0.8 cm. thick. Distally there is great thickening of all layers with a spongy edematous feeling on palpation. There is much submucosal brown-red hemorrhage near the junction of the middle and distal thirds. Microscopically the mucosa shows multiple areas of superficial hemorrhage. The submucosa is considerably thickened and replaced by hyaline material. Throughout this layer there are loosely arranged coarse collagenous fibers producing rather marked fibrosis. The muscle shows areas of edema plus occasional areas of fibrosis. There is a minimal chronic gastritis with moderate atrophy and intestinal metaplasia af the mucosa."

Gastroscopy, 365 days: "The distal stomach has been resected. On the posterior wall at the distal end near the greater curvature, there is an enterostomy stoma, through which there is bile reflux. The size of the stoma appears adequate, and its edges, which were only seen briefly before the reflux began, appear healthy without ulceration or free suture. Everywhere the mucosa appears normal. There is no evidence of infiltration or sense of stiffness."

Gastrointestinal roentgen series, 367 days: "Normal posterior gastroenterostomy without evidence of stomal ulcer."

CASE XII. Twenty-seven years old. Embryonal carcinoma of the testis. Treatment: 22,400 roentgens over fifty day period; 5,600 r to epigastric portal and 5,600 r to lumbodorsal portal.

Gastroscopy, 345 days: "Although the antrum is immobile, there is no evidence of infiltration. The pylorus is normal functionally and anatomically, and a peculiar picture is presented by the rhythmic contractions of the pylorus since there is no peristalsis in the antrum itself. The mucosa is normal in all respects except for several deep pigmented spots scattered along the greater curvature."

DISCUSSION

It is clear that only those areas of the stomach which had been directly in the path of roentgen irradiation showed changes demonstrable by endoscopy. It is also clear that the size of the radiation dose was not the only factor determining the degree of subsequent gastric damage, suggesting individual variation in irradiation tolerance which precluded accurate prediction of the gastroscopic picture in any particular patient. This is not to say that experience with this group of patients has failed to indicate a satisfactory maximum safe dosage; in fact, the Radiation Therapy Section at this hospital has succeeded in balancing the minimum effective dose against the maximum safe dose so effectively that the Gastrointestinal Section does not expect to see more post-irradiation gastritis.

The most characteristic part of the endoscopic picture was heavy submucosal infiltration of the involved area, with consequent stiffening and fixation of the gastric walls. In the antrum this led to a tubular deformity which neither expanded on inflation nor collapsed after instilled air had passed through the stomach. It was interesting to note that this infiltration did not occlude the pyloric canal; rather, the pylorus typically remained patulous, as though there was paralysis of the sphincter musculature, allowing an unusual amount of bile reflux and often interfering with maintenance of satisfactory gastric inflation. As would be expected, submucosal infiltration was attended by notable sluggishness or absence of antral peristalsis. But poor peristalsis was also found in post-irradiation stomachs which showed no infiltration or fixation, a finding which suggests that it was radiation injury to the local neuromuscular mechanism rather than mere mechanical interference which interrupted motility. It is recognized, of course, that accurate gastroscopic interpretation of gastric motility is probably seldom possible, especially in view of large doses of pre-examination atropine, but some opinion regarding this aspect of the gastric situation is almost always possible. Statements concerning motility in the case reports are felt to be valid.

Of mucosal lesions, deep clean-cut ulceration was most important. In one case the course of an ulcer was closely followed, and its complete healing without residual contraction or distortion was eventually seen. This and the slowness of healing were features which differentiated the radiation ulcer from simple peptic ulcer. It was a matter of considerable surprise to find at gastroscopy no residual abnormality to indicate the site of an ulcer estimated at 2.5 by 1 cm. in diameter visualized three months previously.

The chronicity of the observed mucosal and submucosal damage in several of the cases was an important feature. At the onset of the study it was wondered if the ulcers would heal spontaneously in view of the fact that some were followed several months without change. In other cases the ulcers first appeared many months after the completion of irradiation. Because the swelling of the antral submucosa likewise was found as long as a year and a half following treatment, it was interpreted erroneously as being due to chronic infiltration. The static nature of this localized edema for long periods is not easily explained.

Petechiae, pigmentation and excess mucus were common but not distinctive features of the mucosal changes. Paleness reflected the anemia of some of the patients.

Examinations following subtotal gastric resection with enterostomy showed the usual picture of postoperative stomach with no feature to indicate the prior post-irradiation changes, nor were stomal ulcers or significant postoperative gastritic changes found. In each case the damaged portion of the stomach had been completely resected, and the final results were satisfactory clinically and endoscopically.

The correlation between the gastroscopic picture and the pathology of the resected specimens was fairly satisfactory. That which was taken for submucosal infiltration, however, proved to be mere edema. In addition, the large amount of fibrosis underlying the post-irradiation ulcer was an unexpected finding in view of the remarkable absence of contracture about the healing ulcer, gastroscopically observed.

When the gastroscopic findings are compared with the roentgen findings, the only important discrepancy is seen to be that of detection of ulcer. Each method brought to light such lesions not visualized by the other. Specific comparisons are not important here, but it was found that the ulcers missed by gastroscopy were those which were hidden in narrow distorted antrums.

The diagnosis of post-irradiation gastritis has been, of course, no problem, nor should it ever be. The entity should disappear as a result of the present experience. There is hardly need for a differential diagnosis, but one notes that in a case of luetic gastritis Carey and Ylvisaker[3] have described a gastroscopic picture similar to that of post-irradiation gastritis.

SUMMARY

Gastroscopic studies in twelve patients who had developed post-irradiation gastritis following intensive radiation treatment for malignant disease showed remarkably constant and characteristic gastric changes. The picture included marked edema with tubular deformity and fixation of the antrum, similar fixed patulousness of the pylorus, and clean deep chronic ulcers which healed without contracture. Following subtotal gastrectomy with posterior gastroenterostomy, the picture was that of normal postoperative stomach. Pathologic and roentgenographic studies in general corroborated the gastroscopic findings. A new gastroscopic entity is presented, but, because the diagnosis of post-irradiation gastritis should be obvious from the history, the importance of endoscopy lies in the evaluation of the severity of the radiation damage.

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CANCER OF THE CERVIX UTERI*

A REVIEW OF 296 CASES, 1935–1944

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THIS report consists of an analysis of 296 consecutive cases of cancer of the cervix uteri, registered in the tumor clinic of a general hospital from 1935 to 1944, inclusive, with particular reference to methods of treatment and end results. The renewed interest in the radical Wertheim operation as the treatment of choice in selected cases makes it imperative to report the results obtainable with radiotherapy, since Meigs[5] has stated that radiation therapy is at a standstill. Many previously reported series consist of cases collected over a period of fifteen to thirty years, when methods of radiation therapy were changing rapidly. To quote the cure rates obtained in such a series is almost like quoting the surgical cures of cancer of the breast before Halsted. Other series reported, especially from large teaching clinics, represent the collective work of many individuals with very different knowledge, experience and skill. A noteworthy exception to this practice is the series of Pitts and Waterman[7,8] and Waterman and Di Leone.[12] Their results demonstrate the importance of personal, individual management of a large group of patients by technically good and relatively constant methods.

SOURCE OF MATERIAL

All patients admitted to the hospital with proved cancer of the cervix have been registered in the tumor clinic. Private, ward service and dispensary patients are included. Indigent patients are accepted for treatment. The proportion of Negro patients treated is somewhat higher (21 per cent) than that of the community (13.5 per cent). Most of these are medically indigent, indicating a slight preponderance of the less favored economic groups in our series. Survival rates among Negro and white patients are the same, indicating that they received comparable treatment (Table x).

Stage of disease has not determined the acceptability of cases for treatment, except that patients too ill to report for roentgen therapy as out-patients frequently could not receive treatment, and were subtracted from the determinate group for that reason. On occasion it was possible to admit such patients to the hospital for roentgen therapy; if treated, they are included in the determinate group, even though many never improved enough for radium therapy (22 of 208). All these are among our failures and also most of those requiring admission for preliminary roentgen therapy, even though radium could later be used.

PATHOLOGY

All cases in the determinate group had histopathologically proved cancer. Only 1 case was considered carcinoma in situ. The pathologic report in 203 cases was squamous cell carcinoma and in 5 cases was adenocarcinoma. (Cases of adenocarcinoma of the corpus uteri involving the cervix secondarily are not included.) There was no significant difference in survival rate.

INDETERMINATE CASES

This analysis is based upon a determinate group of treated cases from which conclusions can be drawn. It is necessary to define those cases to be excluded from the determinate group (Table 1). In general, the postulates laid down by Martin, Munster and Sugarbaker[3] are followed, with one im-

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portant exception: we do not include cases which were admitted with cancer recurrent after previous treatment elsewhere. We believe recurrent cases belong to the original treatment series of which they were a part at another clinic; that including them in our results would represent duplication of reporting. Many such recurrent cases presented themselves with a healed primary lesion for treatment of metastatic disease. Recurrent cancer might have been excluded from consideration by various methods: Many had no biopsy; many had no treatment other than terminal nursing care. We consider them indeterminate from the standpoint of analyzing the results of treatment.

TABLE I

SELECTION OF DETERMINATE CASES

	1935–1942	1935–1944
Indeterminate	65	88
Recurrent cancer	23	33
Untreated	31	37
Consultation only	5	9
Died, intercurrent disease	5	8
Lost, well 3 years	1	1
Determinate	156	208
Total admissions	221	296

Recurrent Cancer. A separate analysis of recurrent cancers admitted from 1935 to 1942 showed that of 32 such cases 9 received no treatment and 23 had palliative radiation therapy. The 9 untreated recurrent cancers are included with the other untreated cases in Table 1. Of 23 recurrent cases treated, 3 survived five or more years.

Untreated cases in the five year (1935–1942) series fall into three categories. Of 31 untreated cases, 10 refused treatment and presumably went elsewhere; their present condition is unknown. There were 13 cases unable to report for treatment (distance, physical condition), 3 of whom were moribund, dying one, four and fourteen days respectively after the initial examination. Eight recurrent cases could not be treated because of damage resulting from previous radiotherapy (skin atrophy, colitis, pelvic cellulitis or slough). The other recurrent case referred to above was one of those moribund on admission (liver metastasis, healed primary cancer).

Consultation only describes 5 patients who were seen in consultation while under treatment elsewhere or followed by us at the request of another clinic. Two of these patients are known to be living seven and fourteen years respectively. None of these patients were treated by us, nor included among our survivors.

Intercurrent Disease. Several patients dying from unrelated diseases cannot be considered either cures or failures of treatment. Presumably their prognosis was the same as that of the whole series and their exclusion from the determinate group should have no statistical effect. No case was excluded from the determinate group for this reason unless the cause of death was known. The 5 cases from the five year series are tabulated below, with survival time.

1. Pulmonary tuberculosis: 2 months.
2. Coronary thrombosis, ruptured ventricle: 30 months.
3. Cerebral thrombosis: 13 months.
4. Hypertensive cardiovascular disease: 34 months.
5. Carcinoma of bronchus: 39 months.

STAGE OF DISEASE

The classification of Schmitz and Nelson[9] has been used since it is practical and well correlated with the clinical course of cervical cancer. In this report Group I is defined as a small, limited cancer, apparently confined to the portio vaginalis, not over 2 cm. in diameter. Group II is a cancer involving most of the cervix (or a small endocervical cancer whose exact extent is usually greater than can be seen) but not extending beyond the cervix. Group III is a cancer invading parametrium or vagina by direct extension. Group IV is the cancer with a frozen pelvis from infiltration out to the lateral pelvic wall, or with distant metastasis, including nodules at the vaginal introitus.

The following data have been calculated in this series (Tables II, III, IV):

TABLE II

STAGE OF DISEASE AND SURVIVAL RATE
Determinate Cases
1935–1942 (5 years)

Group	I	II	III	IV	All
Alive	14	40	24	2	80
Total	16	60	57	23	156
Rate	87.5%	67%	42%	9%	51%
		1935–1944 (3 years)			
Alive	24	56	55	5	120
Total	25	81	73	29	208
Rate	96%	70%	52%	17%	57%

TABLE III

RACE AND STAGE OF DISEASE
(Including some indeterminate cases)

Group	I	II	III	IV	All
White	22	72	63	27	184
Negro	5	14	18	21	58
All cases	27	86	81	48	242

TABLE IV

DURATION OF SYMPTOMS AND STAGE OF DISEASE

Group	I	II	III	IV
White	5 mo.	7½ mo.	8 mo.	11 mo.
Negro	3 mo.	5 mo.	7 mo.	14 mo.
All	5 mo.	7 mo.	7½ mo.	12 mo.

The downward trend of survival with respect to duration of symptoms confirms the clinical classification of cases.

An analysis of those cases treated up to 1939 with respect to duration and survival for three years produced a paradoxical result. Of 33 Group II cases, 21 living patients had symptoms for an average of seven months and 12 who died, for 9½ months. On the other hand, of 41 Group III cases, the 21 survivors had symptoms for 7½ months, and 20 who died had symptoms only 5½ months—shorter average duration than the Group II cases. We conclude that this group had more highly malignant cancers, with rapid growth, greater invasion and more severe symptoms leading to earlier, yet fatally late, diagnosis and treatment (Table V).

TABLE V

STAGE OF DISEASE AND DURATION IN MONTHS WITH RESPECT TO SURVIVAL FOR 3 YEARS
1935–1939

Group	I	II	III	IV
No. of cases	10	33	41	21
Alive	3½ mo.	7	7½	*
Dead	*	9½	5½	11½
All	3½ (0–10)	8 (1–24)	6½ (0–24)	11½

* Only 1 patient in each of these categories.

CAUSES OF DELAY

The failure of the patient to seek advice after the onset of symptoms accounted for delay in diagnosis and treatment in two-thirds of the cases. Usually this was due to the patient's ignorance of the importance of unusual bleeding or discharge. For example, many patients date the onset of their illness to spontaneous vaginal bleeding; unless the specific question is asked they forget or ignore post-coital bleeding occurring weeks or months earlier. Rarely, patients defer consultation because of fear or excessive modesty.

In one-third of the cases, delay up to twelve months was due to the failure of one or more physicians to make a diagnosis. The most frequent medical errors are: hormone medication without examination, under the assumption bleeding is functional; medication to control bleeding pending future examination; treatment for some other condition such as myoma or salpingitis, cystitis or hemorrhoids; and deferral of examination "until you stop menstruating."

AGE INCIDENCE

Particular attention is called to the frequent occurrence of cervical cancer before the age of forty (Table VI). Fifteen cases (5 per cent) were from twenty to twenty-nine years of age, and another 20 per cent from

thirty to thirty-nine. We have noted that cervical cancer occurs earlier in Negroes (Table VI). The maximum incidence, of course, is in the fifth and sixth decades.

TABLE VI

AGE INCIDENCE AND RACE
(Including indeterminate cases)
1935–1944

Age	White	Negro	All
20–29	7	8	15
30–39	41	14	55
40–49	65	20	85
50–59	63	15	78
60–69	43	7	50
70–79	5	2	7
80–	3	0	3
All ages	227	66	293

TABLE VII

AGE AND STAGE OF DISEASE
(Including some indeterminate cases)
1935–1944

Age	Group I	Group II	Group III	Group IV	All Groups
20–29	2	4	2	3	11
30–39	2	24	16	3	45
40–49	9	23	22	16	70
50–59	12	14	22	15	63
60–69	2	19	17	6	44
70–79		1	1	4	6
80–		1	1		2
All ages	27	86	81	47	241

Age apparently has some influence on the survival rate. It is our impression that very young patients (twenty to twenty-nine years) do well, but there are too few to be statistically significant, and that patients nearing the menopause do poorly. An analysis of the Group II and III cases for correlation between age and survival suggests that postmenopausal patients do better than those under fifty (Table VIII). Group I and IV cases were not tabulated by age, since 95 per cent of the former survive and 85 per cent of the latter die.

CANCER AFTER HYSTERECTOMY

There were 11 cases of cancer of the cervix after previous hysterectomy for other conditions among the 208 patients studied. The number is too small to analyze, except to state that there was no apparent effect on survival rate. Seven of these 11 cases lived three or more years (64 per cent).

TABLE VIII

AGE AND SURVIVAL—GROUPS II AND III
Determinate cases

Age	Died	Alive	Total	Rate
20–29	1	4	5	
30–	21	18	39	45%
40–	20	22	42	52%
50–	12	21	33	64%
60–	7	24	31	77%
70–	1	1	2	
80	1	1	2	
Group II and III total	63	91	154	59%
Group I	1	24	25	96%
Group IV	24	5	29	17%

CANCER OF THE CERVIX AND PREGNANCY

Only 2 cases of carcinoma of the cervix were referred while pregnant. One has survived nine years after radium therapy and total hysterectomy in the fifth month of gestation (no cancer found in the surgical specimen six weeks after radium). The other stopped treatment begun after cesarean section in the eighth month of gestation, returned seven months later with advanced disease, and died after further roentgen therapy. Three other determinate cases probably had cancer at the time of delivery and have died, 2 with bizarre, widespread metastasis.

CANCER OF THE CERVIX AND SYPHILIS

We are convinced that there is a definite correlation between cancer of the cervix and syphilis. In this series we have had to depend upon serologic diagnosis in almost all cases. Relatively few patients gave a history of infection or of previous antiluetic therapy. Such information as we have is too scanty and unreliable to correlate arsenical treatment with cervical cancer. There are very few reports on the incidence of syphilis

in cervical cancer, so this series is reported in detail.

TABLE IX

SYPHILIS ASSOCIATED WITH CANCER
(All cases having serologic tests, 1935–1944)

Total Series	Serology Negative	Serology Positive	Total	Infection Rate	Expected* Infection Rate
228 white	108	19	127	15%	2%
68 Negro	33	15	48	31%	25%

* Syphilitic infection rate for females in Delaware, from the State Board of Health.

No significant variation in the extent of disease could be found in syphilitic cases. There was no apparent difference in the survival rate of syphilitic cases. In the determinate group of 208 cases there were 93 white patients surviving three years; 65 had serologic tests and 9, or 14 per cent, were positive. There were 27 Negro patients surviving three years or more; 24 had serologic tests and 8, or 33 per cent, were positive. These survival rates correspond almost exactly with the incidence of syphilis in the entire series.

RACE

Three significant findings are reported with regard to the relation of cervical cancer to race. First, it appears at an earlier average in Negro women (Table VI). Second, the disease is usually more advanced on admission (Table III). Third, there seems to be no difference in curability in spite of this (Table X). We can only explain this last finding by an impression we have formed: the fortitude and stamina of the Negro patient enable her to survive treatment one would hesitate to use on the white patient. The earlier incidence is probably due to earlier pregnancies, earlier venereal infections, and less medical attention for chronic cervical infections.

SURGICAL INDICATIONS

There are a few cases in which surgical treatment is strongly indicated. In this series there was 1 case treated by surgery alone. This patient had an amputation of the cervix for carcinoma in situ, and has remained well over three years. One patient had a vaginal hysterectomy for third degree prolapse following preliminary contact roentgen therapy of the protruding cervical cancer. One pregnant patient had a total hysterectomy for suspected residual cancer six weeks after moderate radium therapy; the surgical specimen was negative. One patient had posterior colpotomy for a pelvic abscess.

Two patients, both of whom died shortly, had hysterectomy for pyometra in 1935. Since then we have treated all cases of pyometra by repeated office dilatation, intrauterine irrigations, removal of slough, and chemotherapy. A most useful agent in treating such cases is zinc peroxide applied daily as a creamy suspension or by insufflation of the powder. This chemical releases nascent oxygen gradually over a twenty-four hour period, and is very effective in controlling the foul, anaerobic infections always encountered. Pyometra not controllable by such methods is due to residual sloughing cancer, and is rarely amenable to surgical cure.

TABLE X

THREE YEAR SURVIVALS BY RACE
1935–1944

	No.	Per Cent	Alive	Survival Rate
White	164	79	95	57%
Negro	44	21	25	57%
Total	208	100	120	57%

PRINCIPLES OF RADIOTHERAPY

It is neither practical nor wise to set up a standard technique to be rigidly employed in all cases. Age, obesity, complicating diseases and prior hysterectomy must be considered in relation to the extent of the disease. Repeated examination of the patient while under treatment is important,

and is often neglected, both by radiologists and gynecologists. It is now generally agreed that combined roentgen and radium therapy is superior to radium therapy alone. Unfortunately, few gynecologists take responsibility for the patient's roentgen therapy, and few radiologists take much interest in the clinical examination of patients referred to them after previous radium therapy. The great majority of the patients in this series had their entire treatment planned and executed by one individual, who was thus enabled to acquire the experience necessary to give adequate irradiation without too high morbidity or mortality from treatment. We have followed certain general principles of radiotherapy in all cases, varying details to suit the needs of the individual case. The results in this series can be ascribed to strict adherence to these principles, which are described below.

(1) *Roentgen therapy should precede radium therapy in most cases.* Bleeding usually stops within ten days and the patient's blood count improves during treatment. (We have seen moderate leukopenia but never anemia resulting from pelvic irradiation.) Infection and slough decrease. Bulky tumors regress, sometimes completely, facilitating radium therapy. Examinations during treatment give valuable information, whereas examination at the peak of intense local reaction to prior radium therapy is seldom satisfactory. Subsequent radium therapy, with its inevitable trauma, is given to a partially devitalized cancer, less likely to be disseminated by the necessary manipulations, to a smaller, easily visible, less bloody, less infected lesion. Exceptions to this general rule occur, notably the early cancer, the endocervical cancer first found at curettage, and the patient who cannot or will not benefit by roentgen therapy (the very obese, crippled, debilitated or mentally infirm).

Gynecologists sometimes fear that patients will not return for radium therapy if roentgen therapy is administered first. This will not occur if they personally supervise the treatment, at least to the extent of seeing the patient weekly. Of 208 cases, we have had only 2 probably curable patients stop treatment.

(2) *Whenever possible treatment should be continuous.* The condition of the patient, such as radiation sickness, severe erythema or extensive slough, may make one or more rest periods imperative, but in general it is planned to give all treatment within six to eight weeks. An interval of more than four weeks between roentgen and radium therapy probably allows the cancer to recover somewhat from the first course of treatment. (Some of the worst recurrent cases we have seen are those given intermittent moderate irradiation until eventual overdosage occurs.)

(3) *The initial treatment plan should be to give the maximum dose tolerated rather than the minimum curative dose.* Some irradiation injuries will occur and are undesirable; they cannot be eliminated entirely without reducing the survival rate. Minor injuries, such as proctitis, pyometra, cystitis and blistering of the skin, are of no importance in the treatment of so lethal a disease. Severe injuries and even death from treatment, if rare, are justifiable. If radical radiation therapy is to be on a par with radical surgery, it must accept similar risks.

(4) *Unnecessary treatment to normal tissues should be avoided* when consistent with the principle just described. The bladder and rectum are protected by displacing them with packing during radium therapy, and by using a retention catheter to keep the bladder empty and away from the radium-bearing uterus. Radium dosage is decreased when a contracted vaginal apex prevents such displacement, and also in cancer of the cervical stump. In the latter, the bladder covers the upper end of the stump since the bladder reflection of the peritoneum was sutured to the posterior vaginal wall at operation, and intestinal loops may be adherent in the cul-de-sac. Perforation of the uterus during dilatation occasionally occurs and contraindicates radium insertion, which is sometimes possi-

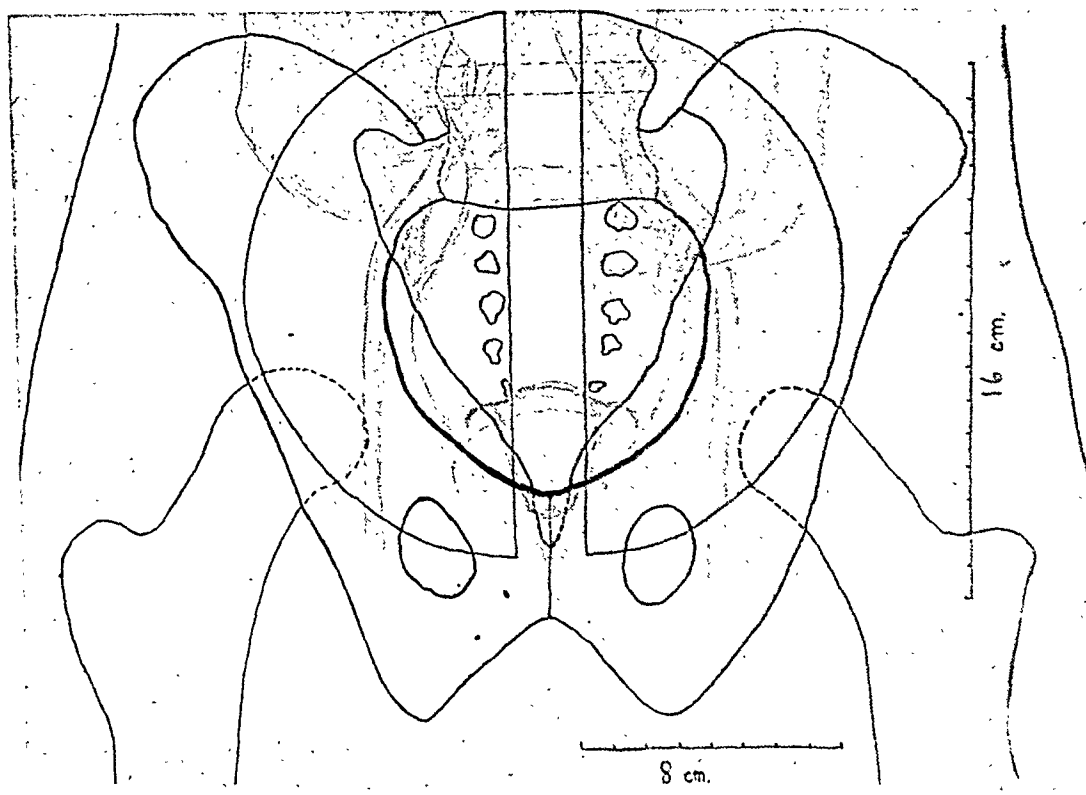


FIG. 1. Anatomic sketch showing relations of 16 by 8 cm. semicircular fields to underlying structures in an average pelvis.

ble at a later date. Perforation of the uterus has never required laparotomy in our experience.

(5) *Roentgen treatment should be limited to the areas of known and probable disease.* By separating the fields in the midline and *not* angulating the beam, the bladder and rectum are spared somewhat and the dose to the parametrium and iliac nodes is not decreased. Large fields should be avoided; they increase the depth dose by back-scatter, at the expense of increased damage to normal tissue. We confine treatment to semicircular fields on each side from umbilicus to mid-symphysis anteriorly, from iliac crest to coccyx posteriorly (Fig. 1 and 2). Anatomically, these fields include in the direct beam the parametrium, true pelvis and iliac vessels to the aortic bifurcation. There is no upper, outer corner to irradiate the cecum and the descending colon unnecessarily. They do not include the groin and femoral neck below. The average patient requires a semicircle of 16 cm. diameter (16 by 8 cm.). Occasionally larger or smaller circles are employed. This type of field was evolved from discussions held in 1935 with Hayes Martin[4] and has been used since then.

Reduction of the area of the treatment field to approximately 100 sq. cm. as described above, permits higher dosage in the direct beam, partly because of less skin damage, but particularly because of the decreased damage to deeper structures, and decreased systemic effect, since the volume of tissue irradiated is proportional to the size of the field. The average patient receives from 2,400 to 3,000 roentgens, as measured in air, through each of the four fields described. Lateral fields were discontinued in 1935 on the basis that the added dose to the parametrium was not enough to justify the increased volume irradiated; we deliver a larger dose to the mid-pelvis with greater economy of the patient's physical resources by increasing the anterior and posterior dose. We have had no single instance of pathologic fracture of the femoral neck in this series.

(6) *The whole patient requires treatment during and after therapy.* It is unnecessary to describe the treatment of anemia, infection, cystitis or proctitis. The use of zinc peroxide for anaerobic infections was described above. Radiation sickness rarely proves troublesome; when it occurs amphetamine or desoxy-ephedrine have been the most effective remedies. Severe post-irradiation colitis (rather than proctitis) sometimes taxes our ingenuity. Dietary management, bismuth, opium, belladonna and allied drugs, metamucil, and starch enemas have all been used, with varying success. Surgical treatment has been necessary in a few cases (see below).

TECHNIQUE

The technique of treatment we have employed most frequently consists of preliminary roentgen therapy (200 kv., peak, filtration 0.5 mm. Cu, half-value layer 0.9 mm. Cu), followed by intrauterine radium therapy within ten days.

Roentgen therapy is given five or six days weekly, alternating anterior and posterior pelvic treatment fields, at the rate of 200 roentgens (measured in air) through each of two fields daily. The usual target-skin distance is 70 cm.; for patients whose sagittal diameter is greater than 20 cm., this is increased to 100 cm. to obtain a larger depth dose. Each skin field is a semicircle measuring 16 by 8 cm. in size (100 sq. cm.); size may be varied from 14 by 7 cm. to 20 by 10 cm., depending on the size of the patient. Obese patients, in whom accurate identification of landmarks is more



FIG. 2. Double exposure roentgenogram with each side of pelvis exposed separately. The beam is centered over the treatment field, hence about 10 cm. from the midline. A plastic lead plug marks the vaginal apex. The target-skin distance is 70 cm.; the fields 16 by 8 cm. are separated 3 cm. in the midline, but the beams overlap at the level of the cervix.

difficult, require larger fields. The fields are separated 2 to 3 cm. in the midline, and the beam is directed perpendicular to the center of each field, since our target is the parametrium and the regional nodes rather than the cervix. Angulation of the beam is avoided, since we wish to spare the bladder and rectum excessive treatment. Very little cross firing results, as shown roentgenographically in Figure 2. Our best results have been in those patients receiving a total dose of 2,400 r to 3,000 r through each of the four fields described in four to six weeks (Table XI).

Pervaginal (transvaginal) roentgen therapy was given to 37 patients. In these cases, external irradiation and/or radium therapy is decreased slightly. We use treatment cones from 3.5 to 5 cm. internal diameter and give 400 to 500 roentgens of unfiltered 140 kv. roentgen rays per treatment. After inserting the cone and engaging the cervix in its open end (horizontal beam, patient in lithotomy position), the beam is angulated laterally toward the parametrium and pelvic wall by rotating the treatment table and patient about the cone as an axis. We have given doses as high as 2,000 r (4×500 r) through each vaginal fornix.

We have been unable to draw conclusions as to the effectiveness of pervaginal roentgen therapy. The slightly poorer results (Table XI) are probably due to its use in more advanced cases. At present we use pervaginal therapy in some cases to supplement radium therapy, but do not employ it routinely. This approach is only practical in patients with a flexible introitus which admits a treatment cone of 4 to 5 cm. internal diameter. The dose to the cervix and broad ligament is increased, but both are within the range of effective radium therapy. It is very difficult to determine the exact direction of the beam beyond the base of the broad ligament; hence the graver problem of controlling nodal metastasis is not solved by pervaginal roentgen therapy.

Radium is applied by placing a 2:1 tandem, 5 cm. in length, in the uterine canal. This contains 75 mg. of radium with 1.0 mm. of platinum filtration, so arranged that 50 mg. lies in the cervical canal and 25 mg. in the lower half of the corpus. It may be left in place for sixty to eighty hours, giving a dose of 4,500 to 6,000 milligram-hours. Occasionally a longer applicator to include also the uterine fundus is used, and the dose increased about 20 per cent. If the vaginal fornices are well preserved, a two-cell colpostat may be used, and the radium dose increased. We seldom give more than 4,500 mg-hr. with the tandem described above; doses of 6,000 mg-hr. should usually be distributed over a larger volume of tissue, as when the colpostat can be used. We have used parametrial needles only twice. On each occasion the patient had carcinoma of the cervical stump, with a palpable parametrial mass in which to insert the needles, and too short a canal and too contracted a vaginal apex to make adequate radium therapy otherwise possible. These 2 patients survive nine and eight years respectively.

Our best results have been obtained with radium doses of from 4,500 to 6,000 mg-hr. given in combination with the roentgen therapy previously described. A few very young patients have tolerated heavier dosage (up to 9,000 mg-hr.), but we believe

TABLE XI

RESULTS OF VARIOUS THERAPY TECHNIQUES

Roentgen Therapy		Radium Therapy (milligram-hours)	Five Year Survival	Rate
External	Pervaginal			
4×2400 −3000 r	—	4500–6000	39/59	66%
4×2000 −2400 r	Yes	4500–6000	21/37	57%
4×3000	—	3600	12/24	50%
4×1500 −2000 r	—	6000–9000	3/3	
—	—	3600–6000	1/4	25%
4×3000 −4000 r	—	None	0/22	0

such doses would be disastrous for most patients. We never attempt to give further treatment to patients who have had combined treatment such as described. We are convinced that continuous treatment gives the best results. The common practice of allowing several months to elapse between radium and roentgen therapy is to be condemned. Roentgen therapy given three months or more (and perhaps less) after radium therapy is valueless if the patient has residual disease and equally valueless if her cancer has been cured by radium.

IRRADIATION INJURIES

Deaths. Four deaths resulted directly from irradiation and 1 indirectly, only 1 of which has occurred since 1935. One patient, not seen by the author, apparently had perforation of the uterus at the first attempt to insert radium. A week or two later radium therapy (3,000 mg-hr.) was given. Twenty days later she had a free perforation of the rectum and died shortly. From the record one may conclude that her death was due to a technical error; that the radium penetrated the uterine wall to lie in contact with the rectum, causing focal necrosis. One patient developed pelvic peritonitis three weeks after radium therapy, probably from an unrecognized tuboovarian abscess that was stirred into activity. One very thin patient suffered severe radiation sickness and died one month after treatment was completed. We believe the dose to her intestinal tract was excessive and that enterocolitis was the cause of death. In 1941 another extremely thin patient developed obstructive symptoms three months after treatment, had a gangrenous terminal ileum removed surgically, and later died from infection and necrosis of the abdominal wall. One patient in 1935 had total hysterectomy for postirradiation pyometra and died from ascending urinary tract infection, an indirect result of irradiation.

Colitis. Many patients had mild to moderate colitis during treatment which subsided without sequelae. (Several patients with recurring bouts of colitis since treatment show roentgenographic evidence of generalized colitis and/or diverticulosis not confined to the pelvic colon, and are not considered irradiation injuries.) Six patients had severe late irradiation colitis with partial to complete obstruction, two of whom required colostomy for relief, the others* subsiding under careful medical management in the hospital. In 1 case, obstruction due to edema and ulceration subsided, permitting closure of the colostomy; the other has a permanent stricture and will require resection. These cases and the death following resection of the ileum have been reported by Spackman.[11] Two patients with pelvic abscesses (1 diverticulitis, 1 tuboovarian) had vaginal drainage with temporary rectovaginal fistulae which closed spontaneously. The role of radiotherapy is doubtful in these cases.

Ulceration of Bladder. Only 2 cases of late irradiation ulcer uncomplicated by recurrent disease were found.

Fistulae. There have been 3 cases of vesicovaginal fistula not due to recurrent disease. One patient, treated in 1935, had the fistula repaired in 1936 and died of heart disease in 1946. A second patient, treated in 1935, had a fistula of long standing at her first return visit in 1946; repair failed. A third patient, treated in 1942 for Group IV cancer of two years' duration, is alive but has refused surgical treatment. (She had received very heavy pervaginal irradiation in addition to a full dose of external radiation and radium in an attempt to control a hopelessly advanced cancer.) Three other vesicovaginal fistulae, and 1 rectovaginal fistula are reported to have occurred from extension of cancer.

Pyometra. As stated previously, this complication is only serious when due to persistent sloughing cancer. It occurred in 35 of 208 cases, 7 of whom died subsequently (none from pyometra, unless we so classify 2 cases in 1935 whose death may have been

* One of these patients, since this article was submitted for publication, has had resection of the colon for stricture eight years after treatment.

hastened by hysterectomy). Since 80 per cent of those with pyometra are among the three year survivors, it might almost be taken as a favorable prognostic sign!

Skin. It is estimated that 1 patient in 20 has marked atrophy and telangectasia from the doses of roentgen rays described (2,400 to 3,000 r per field in four to six weeks). No accurate figures are available. One patient has definite keratotic changes which may require surgical treatment. One patient had postoperative infection and necrosis of the abdominal wall after resection of the ileum as described above.

TABLE XII

SURVIVAL BY YEAR OF TREATMENT

Year	Admitted	Determinate	Five Year Survival
1935	27	17	5
1936	17	10	4
1937	23	15	10
1938	31	22	11
1939	43	34	20
1940	20	14	5
1941	32	25	15
1942	28	19	10
1943	32	21	13*
1944	43	31	17*

* Three year survival.

Bone. No fractures of the femur have occurred in the determinate group. Several pathologic fractures of the pubis have occurred from metastatic carcinoma.

RESULTS OF TREATMENT

From the determinate group of 156 cases treated from 1935 to 1942 there are 80 cases surviving five or more years, or 51 per cent. In the entire series of 208 cases from 1935 to 1944, 120 cases survived three or more years, or 57 per cent. Others have shown that 10 to 15 per cent of treated patients die from recurrent disease between the third and fifth years, which corresponds to the results in this series (Table II).

A summary of the results by years shows a definite improvement in 1935, and little change thereafter (Table XII).

RECURRENT CANCER AFTER FIVE YEAR SURVIVAL

It may be of interest to report the cause of death in cases who survived longer than five years. There were 19 survivors of 42 determinate cases from 1935 to 1937 who might now be living ten or more years. One was lost to follow-up; 1 died from general paresis, and 1 from hypertensive cardiovascular disease in the sixth year. One died from metastatic cancer (iliac nodes, ilium) in the eighth year. Fifteen survived ten years. Since then 1 has died in the twelfth year from hypertensive cardiovascular disease and 1 in the eleventh year from a myosarcoma of the uterus which developed during the ninth year after treatment.

Of the remaining survivors (51 from six to nine years), 1 has died in the eighth year and 2 in the sixth year from recurrent cancer, 1 has been lost, and the rest are known to be alive. In all, we have now seen 4 recurrences among 93 patients surviving from six to twelve years, 1 uterine myosarcoma, 3 deaths from intercurrent disease, and have lost 2 patients. The recurrence rate after five years is therefore less than 5 per cent.

COMPARATIVE RESULTS

It is difficult to compare the results reported by various authors. Inevitably some selection of cases must take place. The absolute cure rate is of value in estimating cancer cures in a given region or population, but cannot compensate for all factors affecting the selection of a limited series. For example, the character of the institution making the report affects selection: a home for incurables admits advanced or recurrent cancers; an established cancer clinic attracts cases in whom previous treatment has failed, and cases for consultation who are under treatment elsewhere. One clinic may refuse admission except to ambulatory patients. Another may not record the primary cancer if it is healed, but only the condition existing on admission. This series is selected to show the results of a particular method of treatment, hence untreated

cases and cases recurrent after inadequate treatment elsewhere have not been analyzed. For the convenience of the reader, all cases are summarized in Table XIII.

TABLE XIII

FIVE YEAR SURVIVAL, CANCER OF CERVIX, BASED ON COMPLETE AND SELECTED TOTALS (1935–1942)

Based on determine group described above	156	80
Plus, 1 case lost while well 3 years	157	80
Plus, 5 cases dying of known intercurrent disease	162	80
Plus, 17 cases with recurrent cancer of the cervix, treated for palliation	179	83
Plus, 6 cases with healed cervix, treated for metastasis	185	83
Plus, 13 cases too ill or to distant to report (untreated)	198	83[a]
Plus, 8 cases of recurrent cancer complicated by radionecrosis (untreated)	206	83[a]
Plus 5 cases treated elsewhere and examined by us	211	85[b]
Plus, 10 cases refusing treatment, probably going elsewhere	221	85[c]

[a] Plus possible survivors treated elsewhere.
[b] Two survivors were not treated by us.
[c] See [a]. No attempt was made to trace cases treated elsewhere.

Comparison with surgical results is even more difficult because of the further selection involved in determining operability. For discussion, we may assume that all Group I and II cancers are operable, that Group III cancers might be accepted by some surgeons and rejected by others, and that all Group IV cancers are inoperable. This assumption makes no allowances for the rejection of surgical patients for age, obesity, and complicating disease, factors which are no bar to radiation therapy.

One of the largest surgical series is that of Bonney,[2] who had 40 per cent five year survivors from 500 surgical cases; 52 per cent of 300 cases free of metastatic nodes and 22 per cent of 200 cases with metastatic nodes. In our series of 156 cases, 133 might have been considered technically operable (Groups I to III) and 78, or 58 per cent, survive. If only the 76 Group I and II cases are considered, 71 per cent survive five years. There are 75 per cent three year survivors (80/106) in Groups I and II, unselected for age or physical condition. These "operable" cases comprise 50 per cent of our series and with the Group III "borderline" cases, 85 per cent, while Bonney's operability is estimated to have been about 60 per cent, and Meigs'[6] about 15 per cent. A similar comparison has recently been made by Arneson,[1] using the reports of Pitts and Waterman. Meigs has stated that surgical removal protects the patient against recurrence *in the cervix*. Our three and five year survival rates in "operable" (Group I and II) cases indicate a 5 per cent rate for *all* recurrences during the fourth and fifth years.

The foregoing discussion leads to two conclusions. First, that no final answer can be given as to the best method of treatment of cervical cancer, for lack of comparative data. As yet no properly controlled series comparing surgical and radiotherapeutic methods has been reported. Such a series no

TABLE XIV

RADIATION RESULTS IN OPERABLE CASES (FROM TABLE II)

	1935–42 (5 years)			1935–44 (3 years)		
Group	Per Cent of Series	Survival	Rate	Per Cent of Series	Survival	Rate
I	10%	14/16	87%	12%	24/25	96%
I and II	50%	54/76	71%	50%	80/106	75%
I, II, III	85%	78/133	58%	86%	115/179	64%
All	100%	80/156	51%	100%	120/208	57%

doubt is under way, but may be subject to the criticism that it represents the work of a group of varying competence, rather than that of an individual. Second, the recrudescence of radical surgical treatment may prove harmful to the majority of patients, since in spite of warnings in the surgical literature, incompetent surgeons feel encouraged to attempt "modified Wertheim" operations.

The problem of reaching a decision as to the proper scope of surgical and radiotherapeutic methods is not one to be solved by debate between the proponents of each method. It is a problem to which everyone interested in the treatment of cervical cancer should seek the answer. It is suggested that the American Radium Society could help solve the problem by supporting a controlled study somewhat as follows: One or several institutions with an adequate supply of clinical material would have to cooperate. Cases for comparison should be selected by careful standards. One individual, the surgeon, should select the "operable" cases. Alternate cases, from this group alone, should be treated surgically; if inoperable, they count as surgical failures, even though subsequently irradiated successfully. The alternate cases assigned to radiotherapy should also be treated by one individual. Both gynecologic surgeon and gynecologic radiologist should be chosen on the basis of his previous experience with the method assigned to him.

Until such a series can be studied, surgeons and radiotherapists will point to differences in classification, selection of cases, technical skill, complicating diseases, and many other factors to explain divergent results, and will never fully accept each other's statements. This report is presented to show the results obtainable by radiation therapy of cancer of the cervix uteri in a consecutive series of previously untreated cases. It is believed that the survival rate is equal to or higher than any reported surgical series, and that radiation therapy is suitable for a larger proportion of patients.

SUMMARY

From a total series of 296 cases registered in the tumor clinic of a general hospital, 208 determinate cases of cancer of the cervix uteri have been analyzed. All previously untreated cases who received treatment in this clinic are included, except eight cases dying of unrelated intercurrent disease and one case lost to follow up when free of disease for more than three years. The relation of survival to stage of disease (Schmitz classification), age, race, and duration of symptoms, is tabulated. A relatively high incidence of associated syphilis is reported. Specific indications for surgical treatment are noted. The non-surgical treatment of pyometra is recommended. The general principles of radiation therapy followed are presented, and the technique used is described. Irradiation injuries and deaths (2 per cent) are reported. A three year survival rate of 57 per cent of all cases and 75 per cent of "operable" cases, and a five year survival of 51 per cent of all cases, 71 per cent of "operable" cases, is reported. Deaths after five years are recorded. A plan for controlled comparative study of surgical and radiation treatment is proposed. A plea is made for more careful and more radical radiation therapy.

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RADON TREATMENT OF CANCER OF THE CERVIX UTERI*

A DETAILED REPORT OF 137 CASES

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IN THE fifteen year period between 1929 and 1944, 137 patients suffering with carcinoma of the cervix uteri have been admitted to the Simpson Radium Institute for treatment. This paper deals with a study of these cases.

In our practice we rely altogether upon radon as our source of radiation. The treatment is carried out in three stages. We attack the primary tumor mass first with a powerful intravaginal applicator placed against the exterior of the cervix. When the tumor mass is so shrunk that it no longer occludes the cervical canal one intrauterine application is given. As a final measure the "pelvic girdle" is irradiated from the skin surface with the radon bomb.

INTRAVAGINAL TREATMENT

It is most important to avoid traumatism, to reduce infection and to stop bleeding. As in malignant tumors elsewhere, the spreading edges of the cancer should be irradiated first. We begin treatment by irradiating the exterior of the cervix. The end of the cervix and the lateral fornices of the vagina are used as treatment areas. The radon applicator is a flat, silver box loaded with several radon tubes laid side by side. The applicator is covered with from 4 to 10 mm. of rubber and a sterile fingercot.

With the patient in the lithotomy position the cervix is gently exposed with a long bivalve speculum. A gold plate 4 mm. thick and large enough to cover the distal third of the inner surface of the posterior blade of the speculum is inserted to help shield the rectum from the rays.

The radon applicator is grasped with an 8 inch rat-toothed forceps and placed anterior to the gold plate either against the end of the cervix or in one of the lateral fornices. A small amount of gauze is gently inserted to push away the lateral vaginal walls and to help keep the applicator in place. The speculum, gold plate and forceps carrying the applicator are left in the vagina during each treatment, being held in place by a double T-binder dependent from the patient's shoulders. The treatments last from twenty to thirty minutes each and are given daily, on alternate days or less often, until from 3,000 to 6,000 millicurie-hours has been given. This course of treatment usually lasts about four weeks.

As a result of these cervical applications the infection, discharge and bleeding are arrested; the visible tumor entirely disappears or is markedly reduced in size; the external os, if obscured by the tumor mass, again becomes visible and the cervical canal, if obstructed, again becomes patent. The intrauterine applicator can then be inserted without traumatism or dilation of the cervix.

DOSAGE

In malignant tumors, the "toleration dose" is usually given, i.e., the dose the surrounding normal tissues will safely bear. As malignant tumors have different degrees of radiosensitivity, there is unfortunately no fixed cancer dose. It is to be noted that a series of seances, spread over days or weeks, causes greater effects on cancer cells and relatively smaller effects on normal cells than the same dose given in a single seance. One should not try, therefore, to cause resolution of the cancer by a *single seance;* better results are to be had if a *series of seances are given.*

With an intravaginal applicator measureing laterally 2.5 by 2.5 cm. screened with 2

* Presented at the Twenty-ninth Annual Meeting, American Radium Society, Atlantic City, N. J., June 9–10, 1947.

mm. of silver and 1 cm. of soft rubber, the single erythema skin dose (e.s.d.) is approximately 290 mc-hr.

If the irradiation is given in two, three, four, or seven equal seances, the dose may be increased 30 per cent (i.e., to 377 mc-hr.); 50 per cent (i.e., to 435 mc-hr.); 60 per cent (i.e., to 464 mc-hr.); and 110 per cent (i.e., to 609 mc-hr.), respectively.

One may give as a rule, about 2.5 e.s.d., i.e., 1,522 mc-hr. (2.5×609) in seven seances to each of the three portals used, i.e. to the end of the cervix and the two lateral fornices.

In the course of a few weeks, a total dose of about 4,566 mc-hr. (3×1,522) may be given intravaginally to the exterior surface of the cancerous cervix, provided there is no overlapping of the irradiations at the surface of the original mucous membrane.

INTRAUTERINE TREATMENT

After the treatment of the exterior of the cervix has been completed the intrauterine treatment is given. As the tumor often extends above the internal os the applicator should extend to the fundus of the uterus.

The intrauterine applicator is a lead tube which can be easily bent to the uterine curve. It has an external diameter of 4 mm. and a wall thickness of 1 mm. These tubes are made in different lengths so as to hold from two to five radon tubes in tandem.

With the patient in the lithotomy position the cervix is exposed with a speculum and the length and curve of the uterus are measured with a uterine sound. An intrauterine applicator of the proper length is loaded and bent to the shape of the uterus. This is gently inserted without dilation, "pulling down," or otherwise traumatizing the cervix. A vaginal pack holds the applicator in place. As a rule only one treatment lasting from two to four hours is given. The dosage is approximately 1,800 mc-hr. with an applicator 7 cm. in length.

TRANSCUTANEOUS IRRADIATION

After treatment of the cervix and the interior of the uterus has been completed external irradiation is given at a distance of 4 to 6 cm. from the surface of the skin. The radon applicator is a flat silver box in which a number of radon tubules, containing from 500 to 1,000 mc. or more of radon, are laid side by side. Four portals are used, two anterior and two posterior. With the patient lying on a table, a balsa wood block 6 cm. square and of the desired thickness is strapped to the patient's skin. A lead guard is lowered around the block. The radon applicator is placed inside the guard and rests upon the balsa wood block.

DIVIDED DOSE TECHNIQUE

The divided dose technique is used for the following reasons:

1. There is no fixed "cancer dose." Each tumor must be treated until it yields or until the "toleration dose" has been given.
2. Tumor cells are known to be most sensitive during mitosis and not all cells of a given tumor are in the process of division at the same time.
3. The exact dose tolerated by any one patient cannot be known in advance. To insure destruction of the growth, the greatest dose should be used that can be given with safety.
4. A much greater total dosage can be given if the treatment is administered in several seances.
5. Giving internal treatments of short duration to the exterior of the cervix precludes the danger of damming up uterine discharge with resulting pelvic infection.

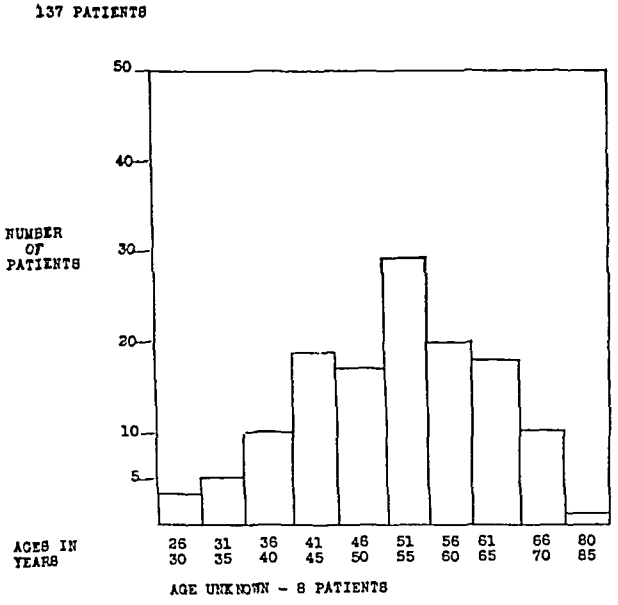
MATERIAL

The patients in our group compare in age, marital status and duration of symptoms with those reported by Healy and Twombly, and many others. The ages vary from twenty-six to eighty-five with 29 patients, or 21 per cent, in the fifty-one to fifty-five year group (Graph 1).

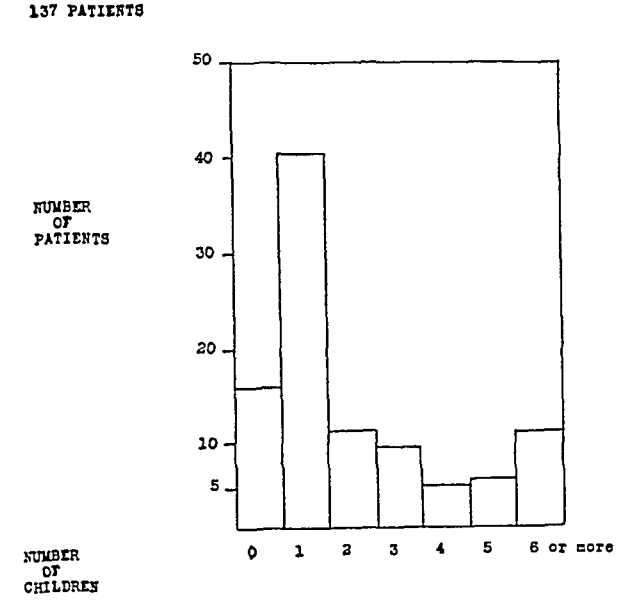
One hundred twenty-nine, or 94 per cent, of our cases were or had been married. Seven had never married and the status of 1 is unknown. Eighty-nine per cent of our patients had borne children, with the majority (74 per cent) bearing several (Graph 11).

The duration of symptoms varied from two weeks to three years. Forty-nine per cent waited six months or longer before seeking medical aid (Graph III).

The biopsies of some of our patients were taken by the referring physician and diagnosed by the pathologist in the local hospital. Many of these pathologists made no effort to grade the tumor in accordance with Broders' classification. Of these cases graded, 4 per cent were in Grade 1, 69 per cent in Grade 2, 25 per cent in Grade 3 and 2 per cent in Grade 4. In our series were 131 cases of squamous cell carcinoma, 5 cases of adenocarcinoma and 1 case of myosarcoma.



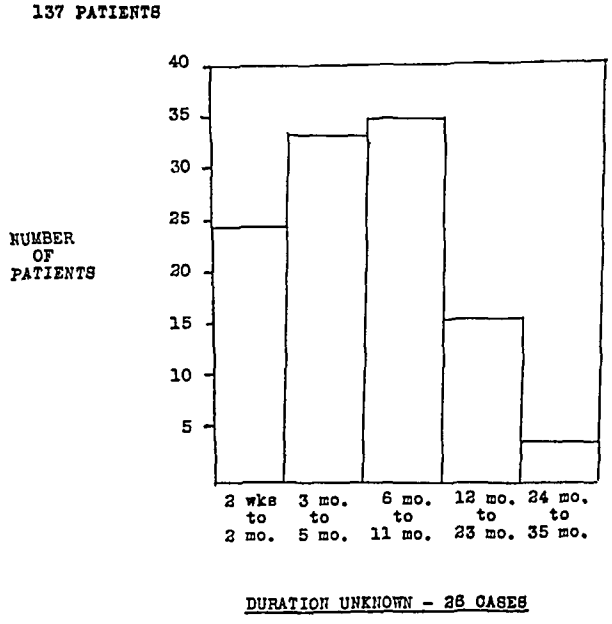
GRAPH I. Ages of patients.



GRAPH II. Number of children borne by patients.

Of our 137 cases, 13 did not complete treatment. Our detailed report is based upon the remaining 124 cases. One of the discarded cases was the patient suffering with myosarcoma of the cervix. This tumor grew rapidly under intense irradiation and was referred back to the surgeon. A panhysterectomy was done. The patient is alive and well now more than three years after operation.

Our classification of cases into stages is based upon the old League of Nations Classification. It was impossible for us to reclassify our old cases at this late date, with any degree of accuracy. Table 1 presents the detailed information on our cases.



GRAPH III. Duration of symptoms.

Seven cases were in Stage I, 42 in Stage II, 37 in Stage III and 35 in Stage IV. The stage of 3 cases is unknown.

Of the 124 cases, 4 died under three years without cancer, 63 died under three years with cancer, 54 lived three years or over without cancer and 3 are living over three years with cancer. Forty-five cases lived over five years without cancer.

Of the 7 cases in Stage I, all recovered except 1 who died under three years without cancer.

TABLE I

RESULTS OF TREATMENT, 1929–1944, ACCORDING TO LEAGUE OF NATIONS CLASSIFICATION (OLD)

	Total		Stage I		Stage II		Stage III		Stage IV		Stage Unknown	
	No.	Per cent	No.	Per cent	No.	Per cent	No.	Per cent	No.	Per cent	No.	Per cent
TOTAL	124	100	7	5.6	42	34	37	30	35	28.3	3	2.1
Dead under 3 yr. without cancer	4	3	1	14.3	2	5	1	2.7				
Dead under 3 yr. with cancer	63	51			8	19	21	56.8	32	91.4	2	66.7
Living 3 yr. without cancer	54	43.6	6	85.7	31	73.8	14	37.8	2	5.7	1	33.3
Living 3 yr. with cancer	3	2.4			1	2.2	1	2.7	1	2.9		
5 year recovery record—106 cases—1929 to 1942												
TOTAL	106	100	6	5.7	34	32.1	30	28.3	33	31.1	3	2.8
Living 5 yr. without cancer	45	42.4	5	83.3	27	79	11	36.6	1	3	1	33.3

TABLE II

RESULTS IN 67 CASES RECEIVING INSUFFICIENT EXTERNAL IRRADIATION, 1929–1944, LEAGUE OF NATIONS CLASSIFICATION (OLD)

	Total		Stage I		Stage II		Stage III		Stage IV	
	No.	Per cent	No.	Per cent	No.	Per cent	No.	Per cent	No.	Per cent
TOTAL	67	100	5	7.5	27	40.3	22	32.8	13	19.4
Dead under 3 yr. with cancer	33	49.2			6	22.2	15	68.2	12	92.3
Dead 3 to 5 yr. with cancer	1	1.5							1	7.7
Living 3 to 5 yr. with cancer	1	1.5					1	4.5		
Living 3 yr. without cancer	32	47.8	5	100	21	77.8	6	27.3		
48 cases—(1929 to 1942)—5 year clinical recoveries										
TOTAL	48	100	4	8.3	18	37.5	15	31.3	11	22.9
Living 5 yr. without cancer	22	45.8	4	100	14	77.7	4	26.6	0	0

Of the 42 cases in Stage II, 2 died under three years without cancer, 8 died under three years with cancer, 1 is living over three years with cancer, 31 lived three years or over without cancer and 27 lived five years without cancer.

Of the 37 cases in Stage III, 1 died under three years without cancer, 21 died under three years with cancer. Of those living, 14 have lived three years without cancer, 1 over three years with cancer and 11 over five years without cancer.

Of the 35 cases in Stage IV, 32 died under three years with cancer, 2 have lived three

years or over without cancer, 1 of which has lived over five years, and 1 has lived over three years with cancer.

Of the 3 cases in which the stage is unknown 2 died under three years with cancer and 1 is alive and well over five years without cancer.

It will be noted that the three year percentage of clinical recoveries is 43.6 per cent and the percentage of five year recoveries is 42.4 per cent.

During the period covered by this report we have come to rely more and more upon internal irradiation. It is well known that glandular metastasis from a squamous cell carcinoma is difficult if not impossible to eradicate by irradiation unless the new growth is very radiosensitive. Taylor and Nathanson in speaking of carcinoma in their book "Lymph Node Metastasis" say, "It is commonly considered that the cures resulting from irradiation alone are probably restricted to those cases in which the disease remains a local process or at most has involved only those nodes immediately adjacent to the cervix."

In Table II, we present 67 cases that we believe have been under-irradiated from the skin surface. These cases have had from none to a total of 16,000 mc-hr. at 4 cm. distance. The high three year (47.8 per cent) and five year recovery percentage (45.8 per cent) in the under-irradiated cases present proof of the fact that patients can get well without much external treatment if the internal treatment is sufficient.

If our deductions are correct the injuries produced by heavy external irradiation to the bladder and bowel, as described by many authors, and to the bony system, as described by Slaughter, are unnecessary.

We believe, however, that the advanced cases, particularly those in which glandular metastasis is known to exist, should receive adequate irradiation. The treatment should be undertaken as a palliative measure, however, and not pushed to the point where injury to normal structures is possible. The one exception would be in radiosensitive tumors wherein even glandular metastases may possibly yield.

SUMMARY

1. One hundred and thirty-seven cases of cancer of the cervix uteri treated with radon between the years 1929 and 1944 are reviewed.

2. The ages of these patients varied from twenty-six to eighty-five, with the largest number, or 21 per cent, in the fifty-one to fifty-five group.

3. One hundred and twenty-nine, or 94 per cent, of our cases were or had been married.

4. Eighty-nine per cent of our cases had borne children. Seventy-four per cent had more than one offspring.

5. The details of the treatment are given.

6. Study of those cases given inadequate external irradiation disclose a five year recovery rate of 45.8 per cent.

7. The five year recovery rate of the entire group is 43.7 per cent.

8. The above result would appear to indicate that irradiation from the skin surface is of secondary importance in early cases of cancer of the cervix uteri.

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CARCINOMA OF THE CERVIX UTERI*

AN ANALYSIS OF 790 CASES TREATED OVER FIVE YEARS AGO

By LAWRENCE A. POMEROY, M.D., F.A.C.S.
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MY ASSOCIATES and I treated 790 patients with carcinoma of the uterine cervix from 1919 to 1940, inclusive. The diagnosis was established by microscopic histopathologic examination in all cases. The degree of cell differentiation was recorded at the time of treatment, or by reviewing the original slides, or (rarely) by referring to the report of the original pathological examination. Figures as to the delay in treatment, after the initial symptoms, were available in all cases.

All patients were treated by irradiation. In the earlier years radium alone was the usual method of treatment. In the later years most patients were treated by both radium and roentgen irradiation. In recent years we have treated the early tumors, with little or no infection, by radium followed by roentgen irradiation and the late and infected tumors by roentgen irradiation followed by radium. For one reason or another, a few of the patients recently treated have received only radium or only roentgen treatment. However, all patients treated are included in the report.

The five year cures are as follows (Table I):

TABLE I

		5 Year Cures
1919–1940	790 cases	24.9%
1936–1940	94 cases	33.8%

Divided into stages (League of Nations) the five year cures are as shown in Table II.

The tumors are classified, according to their gross appearance, as proliferative or destructive. The five year results are somewhat better in the former (Table III).

TABLE II

		5 Year Cures
Stage I	44 cases	63.6%
Stage II	114 cases	39.5%
Stage III	451 cases	23.1%
Stage IV	111 cases	1.8%
"Stump cases"	55 cases	29.1%
Recurrence in vault after panhysterectomy for cancer of the cervix	15 cases	13.3%

TABLE III

		5 Year Cures
Proliferative type	455 cases	27.9%
Destructive type	335 cases	20.9%

The tumors are classified according to cell differentiation. The five year results are as follows (Table IV):

TABLE IV

		5 Year Cures
Well differentiated squamous cell	207 cases	21.3%
Partially differentiated squamous cell	309 cases	26.9%
Poorly differentiated squamous cell	224 cases	25.0%
Adenocarcinoma	50 cases	28.0%

The degree of cell differentiation apparently bears no relation to five year curability. The small difference that exists is in favor of adenocarcinoma. During this period of observation (1919–1940) one sarcoma of the cervix was observed but is not included in the report.

* Presented at the Twenty-Ninth Annual Meeting, American Radium Society, Atlantic City, N. J., June 9–10, 1947.

The oldest patient treated was seventy-eight. The oldest five year cure was seventy-two, at the time of treatment. The youngest patient treated was twenty. The youngest five year cure was twenty-four, at the time of treatment. In 34 patients thirty years of age or younger, 20.9 per cent five year cures were obtained. The disease seems by no means hopeless in these younger women.

The number of pregnancies seems to have but little influence on the percentage of five year cures (Table v).

TABLE V

		5 Year Cures
Never pregnant	67 cases	21%
Pregnant 5 or more times	267 cases	24.3%

The difference in the percentage of five year cures in apparently similar groups of white and of Negro patients suggested the following analysis.

The percentage of five year cures is much higher in white than in Negro patients (Table vi).

TABLE VI

		5 Year Cures
White	659 cases	27.5%
Negro	131 cases	12.2%

Apparently delay in treatment does not account for the difference in results in white and Negro patients (Table vii).

TABLE VII

White	Average delay	9.4 months
Negro	Average delay	9.9 months

The presence of a positive Wassermann reaction seems to be a lesser liability to the Negro than to the white patient. Wassermann reactions were not obtained in all patients in the early years of the series but the following results may have some significance (Table viii).

TABLE VIII

			5 Year Cures
White	Negative Wassermann	253 cases	34.8%
White	Positive Wassermann	37 cases	24.3%
Negro	Negative Wassermann	59 cases	15.3%
Negro	Positive Wassermann	28 cases	14.3%

Even for patients in the same stage of the disease (except for the few cases in Stage iv) the results are better in white patients than in Negroes (Table ix).

TABLE IX

	White		Negro	
	5 Year Cures		5 Year Cures	
Stage i–ii	145 cases	47.0%	13 cases	38.5%
Stage iii	377 cases	25.7%	74 cases	9.5%
Stage iv	84 cases	0.0%	27 cases	7.4%
"Stump"	39 cases	35.9%	16 cases	12.5%

Fifteen cases of carcinoma recurring in the vault after panhysterectomy for carcinoma of the cervix uteri are not included in Table ix.

SUMMARY

1. The five year results of irradiation in a series of 790 cases of carcinoma of the cervix uteri are reported.

2. The influence of stage of disease, gross type, cell differentiation, age and number of pregnancies on the five year results is discussed.

3. Even for patients in the same stage of the disease the results are better in white than in Negro patients. The reason for this difference is not apparent. It does not seem to be due to longer delay in treatment or to poorer results in Negroes with a positive Wassermann reaction.

I wish to thank Dr. A. E. Bennett, Dr. W. F. Boukalik and the house officers at City, St. Alexis, St. Luke's and University Hospitals for their aid in treating these patients and for their interest in the follow-up examinations.

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CANCER OF THE CERVIX UTERI

A STUDY OF FIVE TO ELEVEN YEAR END RESULTS*

By WILLIAM E. HOWES, M.D.

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IN MULTIPAROUS women the uterine cervix is most favorably situated for crossfire by accurately placed radium elements: The portio vaginalis protrudes moderately into the vaginal vault allowing the operator to place radium cells into each lateral fornix; with sufficient capacity of the vault a third radium source can be packed against the vaginal surface of the cervix; in most instances the cervical canal can be entered and a chain of radium tubes inserted.

With such an arrangement 15,000 gamma roentgens can be delivered into the cervix uteri proper, a sufficient dose to destroy squamous cell carcinoma. Unfortunately, only a small minority of all women who apply to any tumor clinic have the lesion so confined. Lucas[10] and Arneson[1] have shown how the intensity from this intracavity radium drops off rapidly with each additional centimeter of shell about these radium sources in the pelvis. Roentgen therapy has been called upon to augment the tumor dose into those pelvic structures beyond the cervix proper.

The Brooklyn Cancer Institute serves a large metropolitan population composed of many racial backgrounds. Cases are referred by other city and private hospitals, by practicing physicians and more recently by the local cancer committee. Because of this about 40 per cent of all admissions have received some treatment before admission.

Recently a patient, Mrs. R. C. (Case IV), who had eight years previously been treated for carcinoma of the cervix reported back to the Institute. Her chief complaint was upper abdominal and back pain associated with diarrhea (Fig. 1). On examination her pelvis was found to be free of tumor. A deep fixed mass, however, could be palpated in the intercostal angle slightly to the left of the midline. Every effort, including exploratory laparotomy, to more accurately determine the exact nature and origin of this tumor failed. A needle biopsy was reported as carcinoma (autopsy was refused). It was postulated that while the carcinoma of her uterine cervix was eradicated from her pelvic organs, some cells had migrated into her periaortic lymph nodes and after years of quiescence had finally multiplied to form this large retroperitoneal tumor which caused her death. The only other conclusion to be drawn is to admit that this retroperitoneal carcinoma represented a second primary growth, probably arising in the pancreas.

Another patient, Mrs. P. G., survived treatment for carcinoma of the cervix for twelve years. In this interval, however, she developed a second primary lesion in the bladder and finally died of a retroperitoneal liposarcoma.

Partly because of the interest aroused by these cases it was decided to review all cases of carcinoma of the cervix admitted to the Brooklyn Cancer Institute from 1936 through 1941, services of Dr. Samuel Wolfe and Dr. Joseph McGoldrick. All admissions with diagnosis of carcinoma of the cervix uteri were traced to death or if living into 1947, an interval of from five to eleven years. The staff of the Social Service Department should be given high credit for the relatively few individuals lost to this follow-up. In these six years a total of 230 women were admitted with the diagnosis of cervical carcinoma confirmed by biopsy. Ten additional cases had to be discarded for lack of proof.

Table 1 lists the end results of all cases reviewed.

Eight women in this group have died, having survived over five years after their original treatment. A short summary of these 8 cases follows:

CASE I. M. G., admitted in 1936. After sur-

* Presented at the Twenty-ninth Annual Meeting, American Radium Society, Atlantic City, N. J., June 9–10, 1947.

viving with few symptoms for nine and a half years, this patient died of recurrent pelvic carcinoma. She had developed a left hydronephrosis and hypertension.

CASE II. A. R., admitted 1936. Following supracervical hysterectomy this patient was referred for a discovered carcinoma in the stump. She was readmitted in 1941 for a tumor which appeared over her pubis. This was reported as a metastatic lesion most probably from the ovary. She lived over five and a half years after her original admission.

CASE III. M. R., admitted in 1937. After five years of comparative good health she became

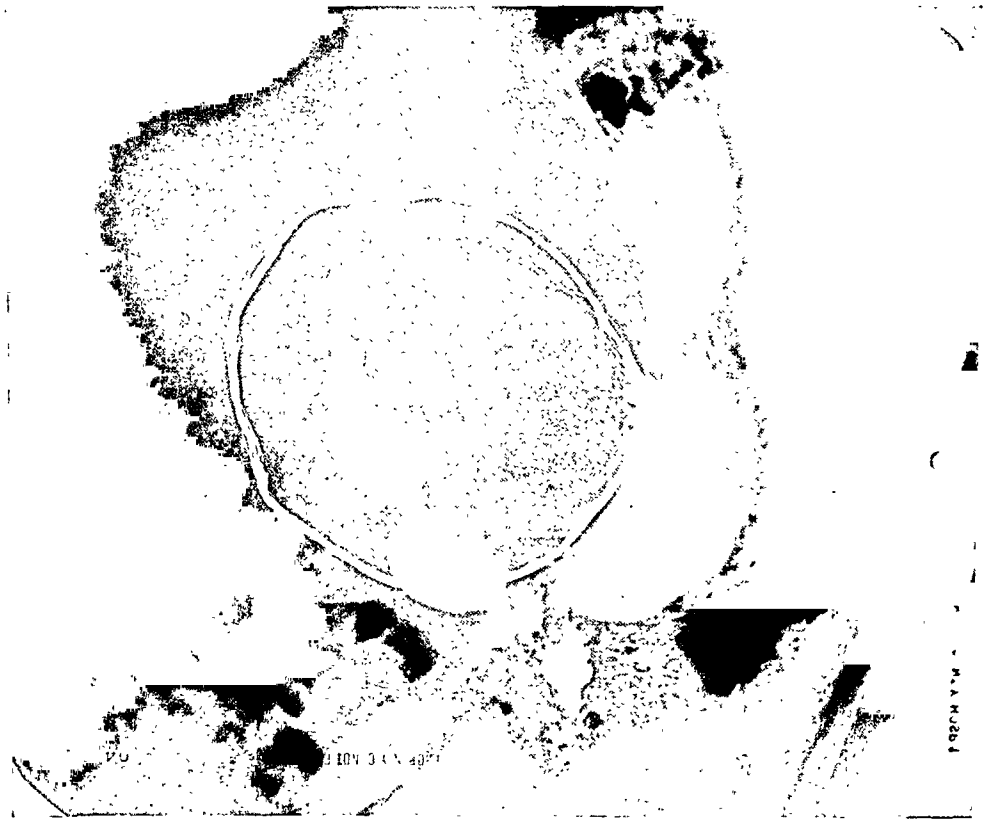


FIG. 1. Mrs. R. C. (Case IV). Eight years previously treated for carcinoma of the cervix. Now admitted with deep fixed mass in upper abdomen as outlined on the roentgenogram. Is this extension of cervical carcinoma or a second primary lesion?

TABLE I

MORTALITY STATISTICS

Year	Total No.	Lost	Died of Cancer or Factors Due to Cancer	Died of Extraneous Disease	Living
1936	22	2	15	0	5
1937	33	4	26	0	3
1938	47	0	42		5
1939	36	0	24[1]	1[2]	11
1940	52	5	34	1[3]	12
1941	40	4	20	0	16
Total	230	15	161	2	92

[1] May have died from a second primary lesion (pancreas).
[2] Died in diabetic coma, no evidence of pelvic carcinoma.
[3] Died following concussion, no evidence of pelvic carcinoma.

distended with ascites and large peritoneal tumor masses could be felt. Could she not have developed a second primary as ovarian carcinoma?

Case iv. R. C. admitted in 1938. This patient's case history was described above. Eight years after treatment for cervical carcinoma she developed a fixed retroperitoneal carcinoma either a second primary or a latent metastasis to the periaortic lymph nodes.

Case viii. J. P., admitted in 1940. This patient developed intestinal obstruction at the sigmoid flexure. A rectovaginal fistula had also broken through. She survived six and a half years.

MULTIPLE PRIMARY LESIONS

Four cases in this series are known to have developed double primary lesions, 2 in the breast, 1 in the ovary and 1 in the thyroid; another individual developed three primary lesions, breast, rectum and cervix; this besides one individual (1934 series) who in addition to her cervical lesion later developed a bladder carcinoma and still later a retroperitoneal liposarcoma. This is a larger number of multiple primary lesions than would be expected in a similar number of women who might have been placed under study for the same time interval as a control group.

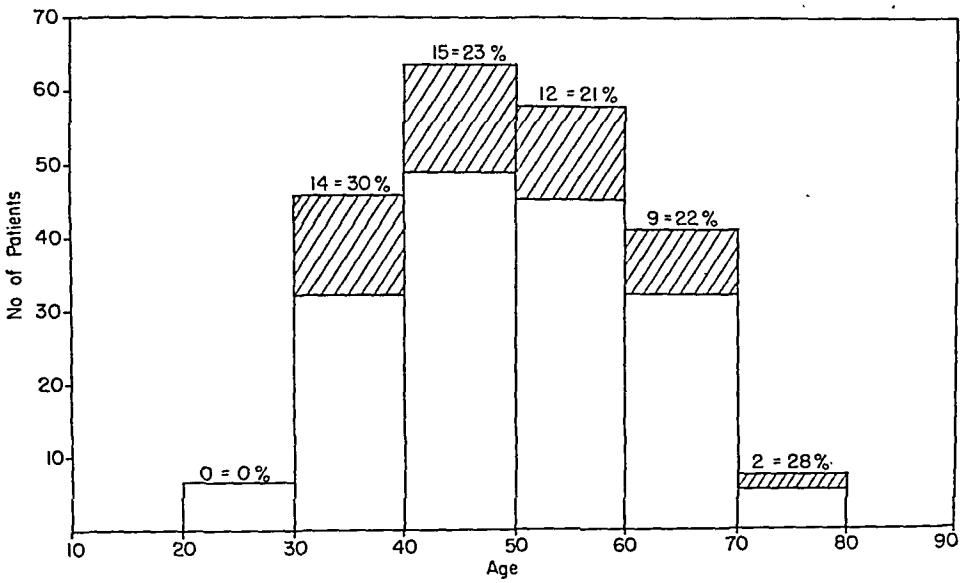


Fig. 2. Age incidence as compared with survival rate.

Case v. M. H., admitted in 1938. A partial intestinal obstruction developed at the level of her sigmoid flexure six years after radiation therapy. There was never any evidence of recurrence of neoplasm in her pelvis.

Case vi. A. G., admitted in 1939. This woman nearly died of an anaphylactic reaction during intravenous injection for urographic study. Because of this reaction she failed to return for follow-up. She was traced by the Social Service Department which found that she had died seven years after admission. Cause of death was not determined.

Case vii. A. G., admitted in 1940. This patient died in diabetic coma over five years after radiation treatment for cervical carcinoma. At her last clinic visit shortly before her death the examiner found no evidence of recurrence or extension of the pelvic tumor.

RACIAL INCIDENCE

Carcinoma of the cervix is known to occur as a rarity among Jewish women. Only 10 women of the Jewish race are listed in this series. This compared with 35 women whose name and religion would indicate that they were of Italian parentage and 35 women of the Negro race.

AGE INCIDENCE

The age incidence closely parallels that of other reported groups. The highest percentage of survivors occurred among those who first reported in their third decade—30 per cent. Not one of those admitted in their twenties survived. This finding is in agreement with the well known fact that cancer, as a rule, becomes disseminated more rapidly in young people (Fig. 2).

NUMBER OF PREGNANCIES

Cervical cancer is more apt to develop in the multiparous woman, in the cervix which has been lacerated through birth injuries. But 4 unmarried women were listed in this series; to these, 7 married women can be added who denied ever having been pregnant. Four others had had but a single pregnancy which ended in miscarriage. All the others had borne at least one child, with one-fourth of all cases having had three or more children. Two women aborted during the early months of pregnancy as a result of carcinoma and irradiation. One of these 2 survives eight years.

PATHOLOGICAL INCIDENCE

From a pathological standpoint, 14 were reported as highly anaplastic growths, the same number as adenocarcinoma. All others were squamous cell carcinoma either of the transitional or more mature prickle cell type. Three of the 14 patients survived with anaplastic carcinoma. Those with the transitional and prickle cell lesions survived in about the same ratio, namely 26 per cent. Those with adenocarcinoma showed a lower survival rate, 14 per cent (Fig. 3).

AUTOPSIES

Although 160 women in this series have died, only 14 autopsies were performed. This low percentage is partially due to the fact that many of these patients were discharged to other institutions or their homes following active therapy at the Cancer Institute.

Eight of the 14 autopsied cases are described as having extensive spread of the carcinoma into the uterine and parametrial tissues. Nine were shown to have advanced hydronephrosis of one or both kidneys, 3 with pyelonephritis and cortical abscesses. Three had metastases to pelvic, mesenteric and peri-aortic lymph glands. Four had distant metastasis to lung, liver and bone (Fig. 4). Two died with a purulent peritonitis most probably associated with intestinal complication. In 4 cases the

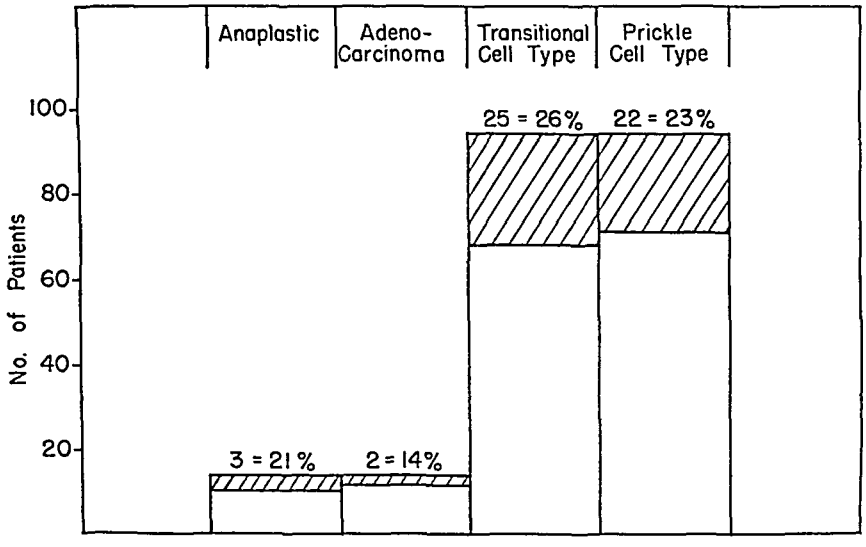


FIG. 3. Pathological type with survival rate.

neoplasm extended into the rectum while in 3 the carcinoma had involved the bladder.

CLASSIFICATION

When first seen all cases were classified in accordance with the classification of Schmitz.[13] For accuracy, any such clinical classification must depend upon the accuity of the examining physician. He may mistake inflammatory masses for cancer, or, on the other hand, he may not appreciate the full extent of the neoplastic process. This latter can be illustrated by a case recently admitted to the hospital where the cervix showed minimal changes simulating cervical erosion. The pathologist, from the small biopsy specimen he had for study, reported intra-epithelial carcinoma. On rectal examination, however, one parametrium was already foreshortened and moderately infiltrated. In view of this evident paracervical extension this case should be classified as Schmitz Group III, though her condition could easily have been mistakenly classified as Schmitz Group I. It is easy to see how errors can be made on both sides of the ledger. Rapid decline in salvage with advancing neoplasm is clearly pictured by this clinical segregation: Schmitz Group I = 61 per cent vs Schmitz Group IV = 8 per cent. The proportionately high salvage in cases of cervical stump is noteworthy, 27 per cent (Fig. 5).

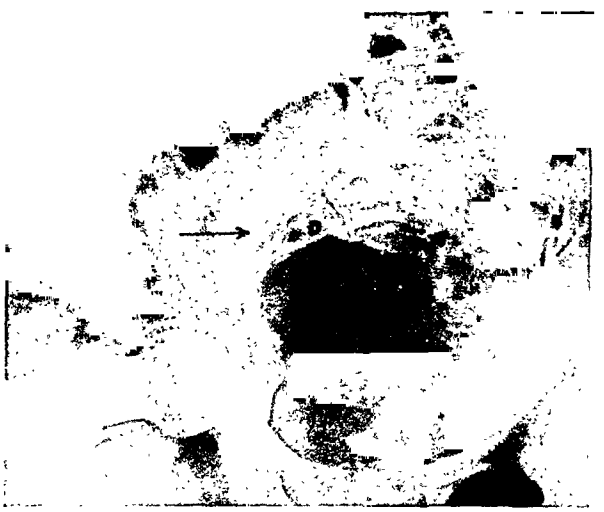


FIG. 4. All metastases to bone were limited to one of the innominate bones and not to the spine or long bones.

BLOCK OF PELVIC LYMPHATICS AND RESULTANT LEG EDEMA

With spread of the carcinoma outward into the parametrial structures the neoplasm not only rings and chokes off the ureter but reaches out and fills the entire pelvis with a cement-like carcinomatous inflammatory mass. Abscess may be locked within this neoplastic process. Such an extension frequently blocks the lymphatics draining the leg and consequently edematous swelling of one leg is an indication of advanced pelvic disease. In many ways this simulates the edema of the arm which oc-

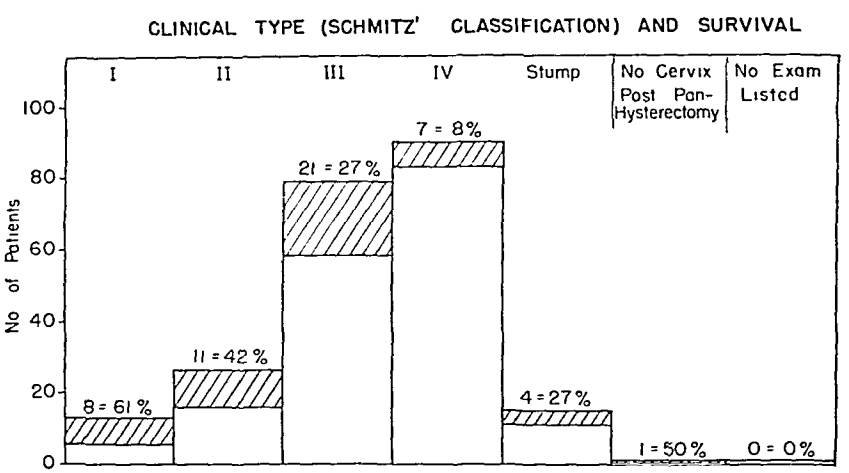


FIG. 5. Clinical type (Schmitz' classification) and survival rate.

curs with advance of carcinoma of the breast into and beyond the axilla. Pressure on the psoas muscle produces flexion deformity of the leg at the hip. This complication does not appear to have received adequate emphasis in the medical literature and in practice its significance is not always understood. In 10 instances in this series edema and flexion deformity of the leg were of sufficient consequence to be recorded as one of the outstanding symptoms.

TREATMENT

Some 40 cases had to have their treatment modified because they received some

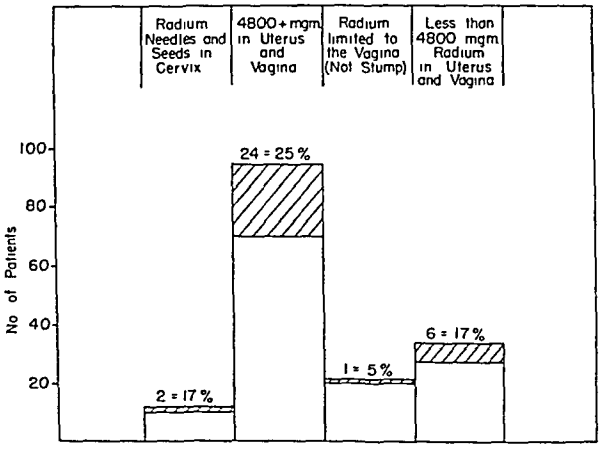


FIG. 6. Modes of radium application with survival rate.

part of their therapy before entering the Cancer Institute. These do not include those operative procedures which preceded the discovery of the cervical carcinoma by several years. Whenever possible radium and roentgen-ray dosage and operations carried out elsewhere have been compiled along with the irradiation and surgery recorded in the Cancer Institute. Whether treated or not, no proved case was deleted from the list.

I. *Hysterectomy.* Operative treatment of cervical carcinoma has, on the whole, given place to radiation therapy. There is, however, always that latent desire on the part of the surgeon to eradicate the neoplasm by one operation. Seven patients were hysterectomized (panhysterectomy), one by the vaginal route. Three of these procedures were conducted in other institutions. Three of these women are alive to date. In considering this relatively high survival rate of 43 per cent, it must be remembered that this small group represents a carefully selected few.

II. *Radium.* As a rule, radium is administered after the method used at the Radium Institute of Paris. A three tube tandem of low radium content is inserted into the uterocervical canal; a colpostat is inserted into each lateral fornix with equal units of radium in each arm, and a cork of the same or lesser strength is placed between the arms of this colpostat. At the Cancer Institute this set is not removed daily for cleaning purposes but is left in situ, when tolerated, up to 100 hours. On occasion this arrangement has to be modified:

(a) With a small vagina just two corks can be placed in the vaginal vault.
(b) Very occasionally a vagina will admit but one cork.
(c) At times the uterine canal cannot be probed (in such instances, except for interstitial sources, radium must be limited to a vaginal application).
(d) When the uterus is small the three radium tubes composing the tandem may have to be reduced to two.
(e) Complications may arise as hyperpyrexia; radium must be removed before the planned time interval.

Radon seeds alone were inserted into the cervix but once in a case of cervical stump. She survived five and a half years before extension of the carcinoma resulted in death. Radium needles were inserted into the cervix and paracervical structures in 11 instances, usually in combination with tandem and colpostat, once in combination with seeds. Two women who were so treated with radium needles have survived to date, seven and six years respectively. Nine have died, surviving an average of thirteen months.

In reviewing the radium dosage, it was

decided to accept 4,800 milligram-hours with radium sources both in the uterus and vagina as a so-called therapeutic dose. A total of 94 women received this or a larger dose with 24 surviving—25 per cent. In 21 instances radium application was limited to the vagina (not including cases of cervical stump); just 1 of these women has survived, 5 per cent. Of the 34 women who received the so-called inadequate radium dose, namely radium in both uterine and cervical canals for less than 4,800 mg-hr., 6 survived, 17 per cent. Some in this latter group, however, had received an indeterminate radium application elsewhere before admission (Fig. 6).

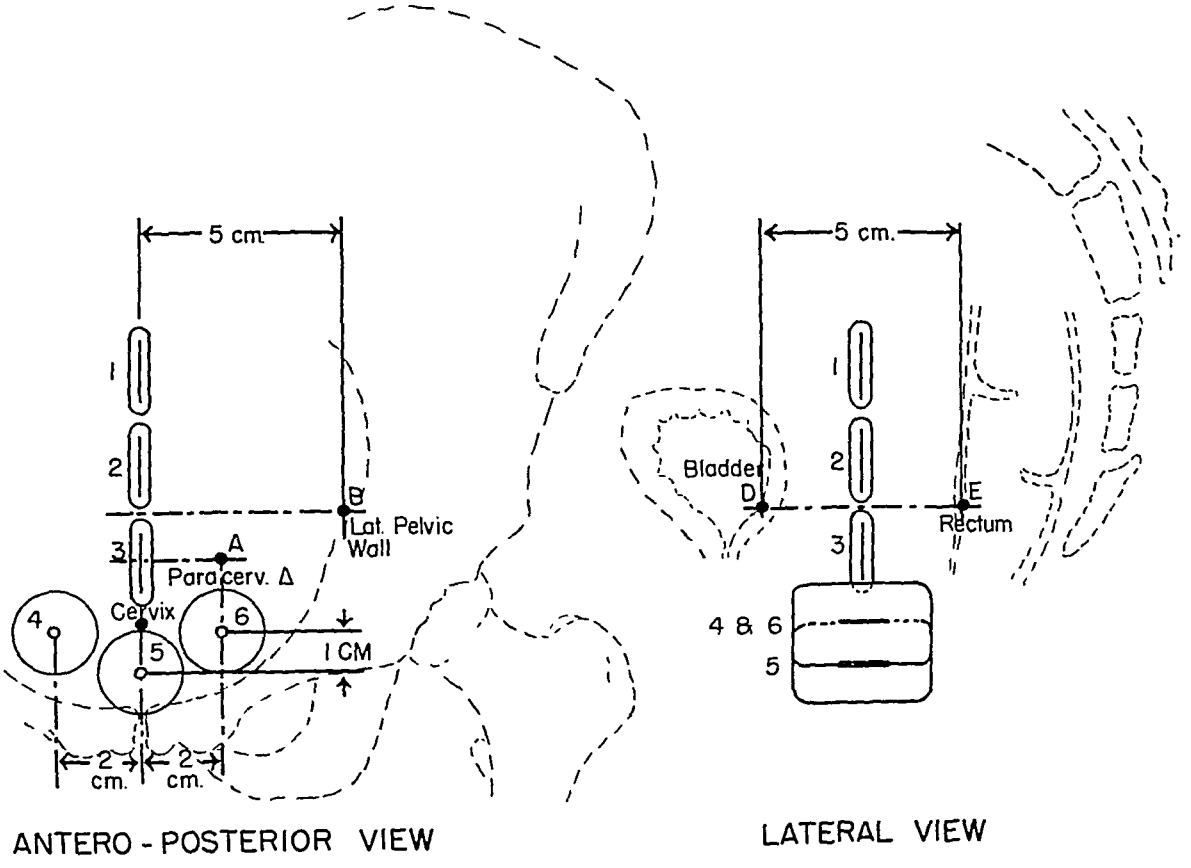


Fig. 7.

Following the publication of Sandler[12] an effort was made to ascertain radium dosage in gamma roentgens to certain fixed points within the pelvis. The following points were chosen (Howes):[7]

A—A point 2 cm. lateral to the center of the lower radium tube in the cervical canal. This is calculated as just lateral to the cervix at the base of the broad ligaments and marks the nearest point to the crossing of the uterine artery and ureter. This is designated as the paracervical triangle and represents the most sensitive location in the pelvis as to the limitation of tolerance of normal structures to radiation (Tod and Meredith[15]).

B—A point 5 cm. lateral to the interspace between the lower two tubes in the cervical and uterine canal and represents the position of the obturator node located within a centimeter of the lateral pelvic wall. Point B may also be thought of as a focal point within the lateral extension of the broad ligament. This is called the lateral pelvic wall.

C—A point ½ cm. below the tip of the lower tube in the cervical canal and at the apex of the circumference of the central cork within the vagina. This represents the external os and is called the cervix.

D and E—Points 2½ cm. anterior and posterior to the junction between the lower tubes in the uterine canal, designed as bladder, D, and

TABLE II

ROENTGENS PER MILLIGRAM-HOUR

Filtration Correction Factor
1 mm. plat. = 0.9
1.5 mm. plat. = 0.8
Figures in parentheses approximate

0.5 mm. Pt. Filtration

r per mg-hr.

Length of Tubes
Over-all 22 mm.
Active 15 mm.

Tube No.	A Paracervical Triangle	B Lateral Pelvic Wall	C Cervix	D Rectum or Bladder
1	0.27	0.23	(0.20)	0.46
2	0.90	0.31	(0.49)	1.07
3	1.92	0.31	(3.42)	1.07
4	0.42	0.14	1.59	0.53
5	0.67	0.19	7.10	0.36
6	2.23	0.46	1.59	0.55
Total	6.41	1.64	(14.39)	4.02
Average	1.07	0.27	(2.39)	0.67

This radium dosage distribution calculation was made by C. B. Braestrup, using dosage tables computed by Wolf.[17]

rectum, E. The bladder and rectum are of course, large mobile organs. D and E were computed as theoretically representing some near point in their wall and the dosage computed should therefore be considered the maximum gamma r delivered to these structures (Fig. 7).

With the radium sources so arranged Braestrup drew up the following tables specifying the gamma roentgens per milligram-hour delivered to these locations (Table II). Such tables can only represent a rough approximation of the actual gamma roentgens delivered in any one instance; as pelves vary in size and shape, no uterus ever lies in an exact central axial plane, the uterus being normally anteflexed on the long axis of the vagina at an angle of 90°. Unless the pelvis is frozen the angle of anteflexion or retroflexion will vary with filling and emptying of the bladder or rectum. In time the constant pressure of the colpostat against the walls of the va-



FIG. 8. *A*, arrangement of radium sources at time of insertion. *B*, arrangement of radium sources 100 hours later.

gina overcomes the normal tonicity of the vagina and allows the arms of the colpostat to spread (Fig. 8). Because of this tendency of the arms of the colpostat to shift, corks or ovoids would appear to be preferable to maintain the radium sources in constant position. To illustrate the use of these tables three radium tubes each of 10 mg. 1 mm. platinum filtration in tandem formation within the uterocervical and three sources of the same strength in the vagina, 1 mm. platinum filtration plus 1 cm. of rubber in the vagina; such a set when left in situ for 100 hours to give 6,000 mg-hr. will deliver the following doses to these predetermined locations:

A	B	C	D and E
Paracervical Triangle	Lateral Pelvic Wall	Cervix	Bladder and Rectum
5,769 r_γ $5\frac{1}{2}$ E	1,476 r_γ $1\frac{1}{2}$ E	12,951 r_γ 13 E	3,618 r_γ $3\frac{1}{2}$ E

Complications Incidental to Radium Applications.

Complications which may arise following such a radium application are well understood. For a discussion they are subdivided into those referable (*a*) to the intestinal tract, and (*b*) to the urinary system (Fig. 9 and 10).

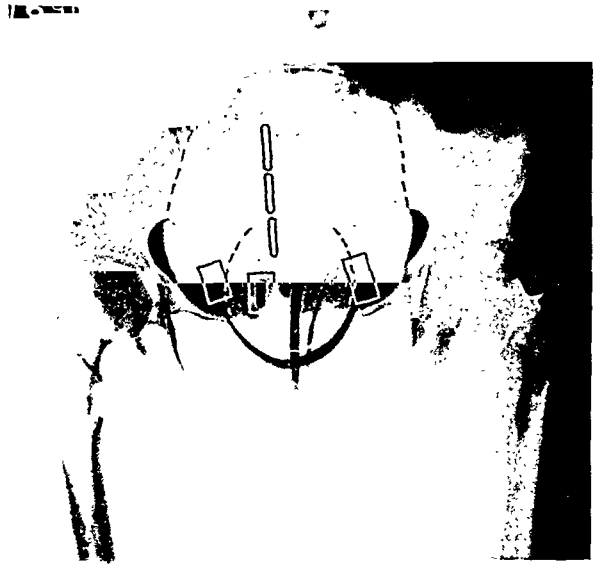


Fig. 9. Anteroposterior roentgenogram (opaque material filling bladder, air in rectum). Radium tubes drawn in for clarification to illustrate relationship of bladder and rectum to radium sources.

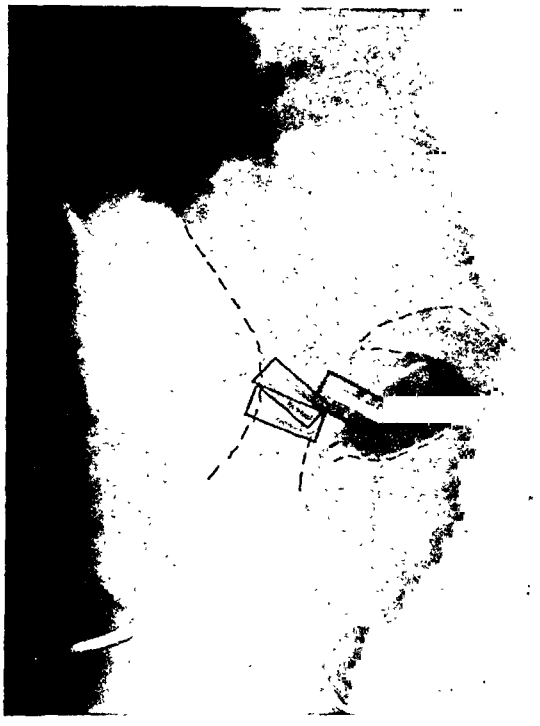


Fig. 10. Lateral roentgenogram (opaque material filling bladder and air in rectum). Posterior wall of bladder, dotted line. Cervical mass protrudes into air-filled rectum, double dotted line.

(*a*) *Rectum, sigmoid colon, cecum and ileum:* Diarrhea with passage of mucus and watery stools often follows removal of radium. If this diarrhea continues unabated for over two weeks there is danger that an ulcerating mucosal lesion may develop, "pseudocarcinoma of the rectum," as described by Todd.[16] With ulceration blood is added to the mucofecal discharges. In this series, 16 women are recorded as having long-continued diarrhea with blood and mucus in their discharge. In several instances this rectal ulceration was biopsied on the presumption that it represented a carcinomatous extension. Corscaden, Kasabach and Lenz[3] have brought out in this regard the significance of reducing the unit radium dosage and increasing the time of radium application, and in discussion giving their experience at the Presbyterian Hospital, they state: "Prior to that change [reducing unit strength in radium capsules]

there was 8.7 per cent of intestinal injury. Since that time there has not been a single intestinal injury" (Fig. 11).

Rectovaginal fistulas, on the other hand, are more frequently the result of carcinomatous extension. The carcinoma as it extends beyond the cervix involves the rectovaginal septum. In time, this neoplastic extension tends to break down, possibly due to the tumor outstripping its own blood supply along with infection, also as a result of radiation effect on the tumor. Rectovaginal fistulas were recorded in 14 instances; 2 of these patients developed in addition a vesicovaginal fistula. The fact that 2 women survived with colostomy over five years would suggest that in at least these instances the fistula was not the result of tumor extension.

Both cecum and ileum may drape over the pelvic inlet and lie in close proximity or be adherent to the uterus. Thus they are exposed to the effects of concentrated radiation. This series records 6 colostomies and 2 ileostomies which were performed to relieve the distressing complications of treatment and disease to ileum or cecum.

(*b*) *Bladder, uterus and kidneys:* According to Ewing,[5] "The natural termination of most cases of uterine cancer is through uremia from occlusion of the ureters." Martin and Rogers[11] demonstrated how the effects of unfiltered radium in close apposition to the ureter will result in ureteral obstruction. With filtration, however, they state that the ureter will withstand at least 2.5 erythema doses without ill effect. Jaffe, Meigs, Graves and Kickham[8] write that in their series no cases of Group 1 or 2 developed hydronephrosis or hydroureter. Two of their cases classified as Group 3 developed partial ureteral obstruction, seven to twenty-one months after irradiation. Both recovered after ureteral dilatation, suggesting that in these 2 instances the obstruction may have resulted from replacement fibrosis. In this series, it is felt that the ureteral stricture was in most instances due to choking off of the ureter by massive growth of carcinoma. This stricture was found to be irreversible and not influenced by catheterization and dilatation or additional radium or roentgen therapy. Leucutia[9] states that no treatment has as

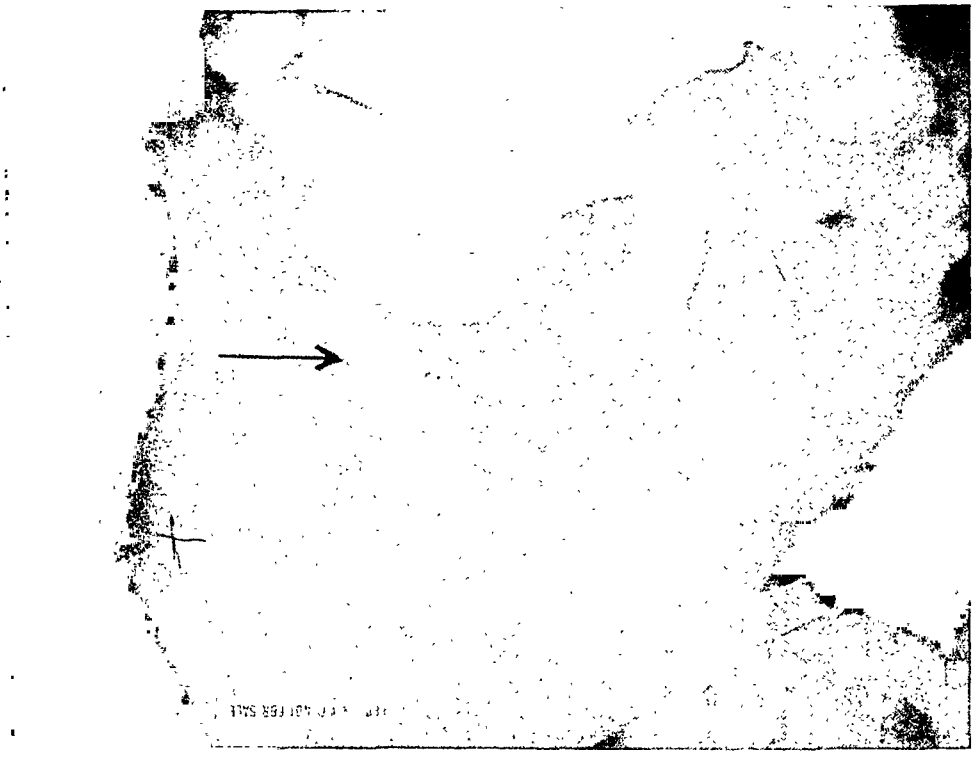


FIG. 11. Narrowed segment upper rectum, complication secondary to radium application.

yet been arrived at which can be deemed successful in overcoming this complication. In this series 43 individuals, 19 per cent, are listed with a non-functioning kidney, advanced hydronephrosis and hydroureter or with pyonephritis. This enumeration, however, is incomplete as many patients did not return for follow-up examinations but were followed through home contact by the Social Service Department.

Women do not bear the unpleasantness and discomfort of nephrostomy or ureteral transplantation to the skin as philosophically as men. But 1 woman in this series had both ureters transplanted to skin; she died within nine months. Transplantation to bowel is associated with a high operative mortality. Of 2 who had the ureters so transplanted, both died; 1 lived three months, the other three years. Three were nephrostomized for impending uremia, and lived for only a short time thereafter. Seven were treated by nephrectomy, 1 of whom is still living over six years. The average survival following nephrectomy was three and a half years, illustrating the advantage of nephrectomy in carefully chosen cases (Drexler and Howes[4]).

Bladder mucosa is not as frequently involved by advancing carcinoma or radiation injury as the rectum. This may be from lack of proper interpretation of the findings as frequency and urgency commonly follow radium removal. Hematuria is often masked by the presence of bloody vaginal discharge. Necrosis of bladder mucosa (post-irradiation) was listed in 4 instances, 1 at autopsy. Calcific encrustation should make the observer suspicious of radiation ulcer. This necrosis was found to be delayed from several months to over a year after irradiation. The urologist frequently reported lifting of the bladder floor and the presence of bullous edema, interpreted as evidence of carcinoma extension rather than radiation reaction. The bladder was marsupialized once and an unsuccessful attempt made to destroy the carcinomatous extension by direct irradiation using contact roentgen therapy; later radium tubes were applied. A more critical analysis of these bladder complications is indicated.



Fig. 12. Pigmentation of skin to illustrate location of lateral portal.

Behney[2] has shown that vesicovaginal fistulas may occur even more frequently in untreated than in treated cases. Fourteen women developed vesicovaginal fistulas which in all but one case appeared to be the result of carcinoma extension. The exception was that of W. K., a young woman; repeated biopsies of her fistulous tract were always reported as negative for carcinoma. She left the state and was lost after four years of follow-up.

III. *Roentgen Therapy*. Throughout 1936 roentgen therapy was delivered routinely through four portals. At that time the total dosage to each skin area was increased from 1,600 r to 2,400 r (in air). After careful deliberation it was decided that this technique did not deliver adequate dosage to the outer pelvis. Lateral fields were therefore added to augment the two anterior and two posterior portals. This roentgen technique was carried out using two anterior, two posterior and two lateral portals throughout 1937 and 1938 (Fig. 12).

Complications Following Roentgen Irradiation to Lateral Pelvis. In 1939 three

patients reported back with pathological fracture of the femoral neck (Strauss and McGoldrick[14]). Upon realization of the significance of this complication the lateral fields were discontinued and the pelvis was crossfired by three anterior and three posterior portals (Fig. 13, *A* and *B*). Since eliminating the lateral portal not a single fracture of the hip has occurred.

Present Methods of Roentgen Therapy. Most women have a sufficient transverse pelvic diameter to accommodate three portals 10 cm. in width anteriorly and a similar number posteriorly. With women of smaller dimensions the width of the portals may have to be cut down to 8 cm. Fifteen centimeters is used routinely as the vertical diameter, this to extend the irradiated block from the iliac crests to the horizontal rami of the pubic bones. The dosage to each skin portal varied from 2,400 r to 3,000 r (in air); this in an effort to deliver 4,500 r to each parametrium calculating crossfire from four portals (Fig. 14, 15 and 16). After such an extensive cycle of roentgen irradiation difficulty was encountered in inserting the planned radium. The vagina had frequently contracted and as a result it became difficult to insert three radium corks into the vaginal vault, or the cervical os had closed and, with the fibrotic post-irradiation changes, difficult to dilate. In view of these difficulties it was agreed to divide the roentgen-ray cycle, giving from one-third to one-half the proposed roentgen radiation, then interrupting for radium treatment. This smaller dose cuts down infection and tendency to bleed without causing the contractures secondary to more extensive roentgen treatment. Roentgen therapy is then recommenced from one to two weeks after the radium is removed and the balance of the therapy completed. Recently this latent period before re-instituting roentgen therapy has been shortened to a few days. Then, too, the central portals, both anterior and posterior, have been divided by a lead strip up to 2 cm. in width thus saving the pelvic structures which lie in the midline (bladder and rectum) from such intensive roentgen irradiation in addition to radium radiation.



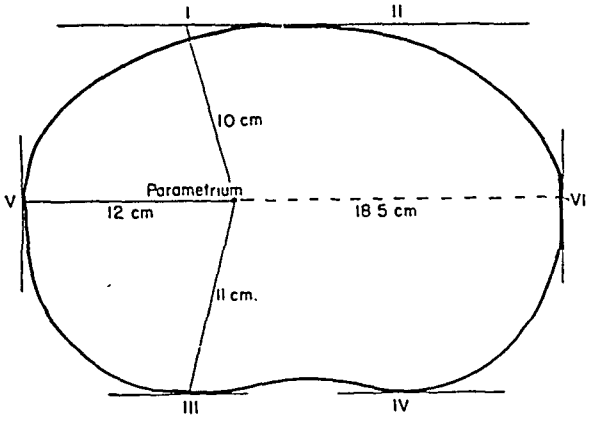
FIG. 13. *A*, pigmentation and peeling to illustrate type of skin reaction and location of portals following pelvic cycle to deliver estimated 5,500 r into parametria. *B*, posterior view.

As an aid to prevent injury to the small intestine, all patients are treated in the Trendelenburg position. This position does not dislodge all the ileal loops out of the pelvis as can be accomplished with pneumoperitoneum, but this positioning in some ways does reduce morbidity (nausea, intestinal cramps and diarrhea).

Addition of Perineal Field. A perineal field was frequently added in the years 1936

through 1938. The perineal tissues will not tolerate over 1,000 r (in air) without producing an uncomfortable skin reaction. This portal was discontinued after calculation that only 10 per cent of the surface dose reaches the depth of the paracervical tissues. No individual receiving this perineal portal survived.

Intravaginal Roentgen Therapy. Direct roentgen irradiation by way of intravaginal cone was used instead of and to augment radium therapy in chosen cases. Seventeen women received such direct intravaginal irradiation up to 4,000 r (in air). Four of these, nearly 25 per cent, are still living, all over seven years. Two of these survivors are cases of carcinoma in the cervical stump. All but one of these survivors received additional intraluminal radium therapy. Ten other women received smaller doses of intravaginal roentgen irradiation of from 800 to 3,000 r. No survivors are

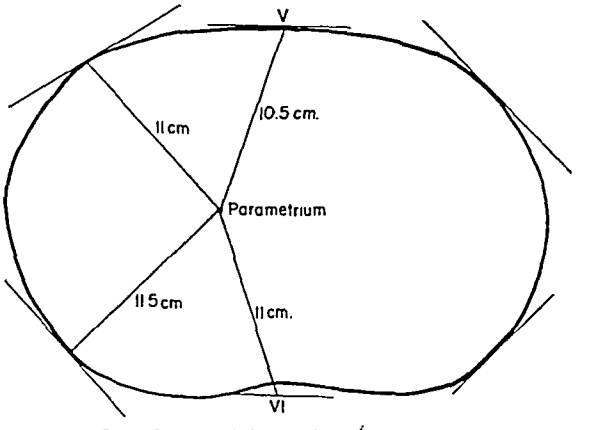


Cross Section of Pelvis, 20 cm x 30 cm
200 KV, 05 mm Cu, 1 Al, TSD 50 cm

Depth Dose to Parametrium, Rt Side

Port	I	II	III	IV	V	VI	Total
Dose/100r per port	44		39		35	17	135 r
Dose/3000r per port	→ 4050 r						

Fig. 14. Pelvis 20 by 30 cm. using two anterior and two posterior and two lateral portals; dose to parametria calculated 4,050 r.

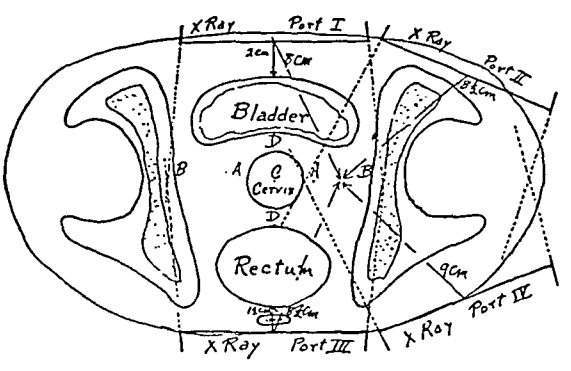


Cross Section of Pelvis, 20 cm x 30 cm.
200 KV, 05 mm Cu, 1 Al, TSD 50 cm.

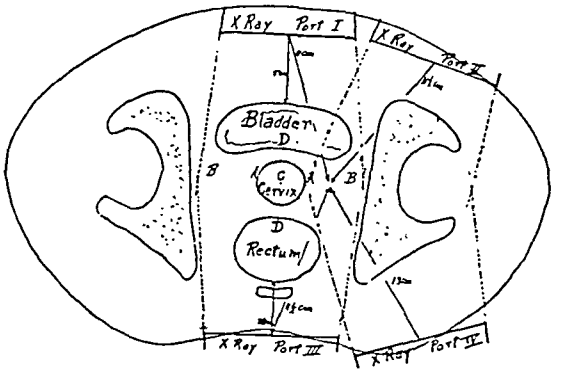
Depth Dose to Parametrium, Rt. Side

Port	I	II	III	IV	V	VI	Total
Dose/100r per port	39		37		41	39	156 r
Dose/3000r per port	→ 4680 r						

Fig. 15. Pelvis 20 by 30 cm. using three anterior and three posterior portals, dose to parametria is increased to 4,680 r, all other factors remaining the same.



Schematic cross section of pelvis 16 cm. in diameter.



Schematic cross section of pelvis 23 cm. antero-posterior diameter (with compression)

Fig. 16. Pelvis 16 cm. anteroposterior diameter, 2,000 r (in air) is necessary to deliver 4,500 r to parametria. Pelvis 23 cm. anteroposterior diameter, 2,600 r (in air) is necessary to deliver 4,500 r to parametria.

listed among those receiving the smaller intravaginal dose.

Estimated Dosage to Parametria. The importance of delivering adequate irradiation into the region of the parametrial structures has been emphasized by Frazell.[6] By using three anterior and three posterior portals a tumor dose of 4,500 r can be delivered to the parametria. To this is added from 5 to 1.5 erythema doses delivered by gamma radiation to the paracervical triangle and the lateral pelvic wall. The equivalent of 13 erythema doses (paracervical triangle) and 9 erythema doses (lateral pelvic wall) has been accumulated to these parts by these two modalities usually in a two month interval. The proportionately higher survival rate in the latter three years of this study, 1939, 1940, 1941, is ascribed to this plan of treatment.

SUMMARY

1. Two hundred thirty cases with a proved diagnosis of carcinoma of the cervix admitted to the Brooklyn Cancer Institute in the years 1936 through 1941 inclusive are studied. This allows a follow-up of from eleven to five years.

2. Classification is made as to race, age incidence, and number of pregnancies. Survival from a pathological and clinical classification is tabulated.

3. The method of treatment is summarized with discussion of the end results and complications, weighed against the particular therapy received.

4. The larger percentage of survivors appears to have been obtained when radium dosage is delivered up to 5.5 erythema doses into the region of the paracervical triangle (parametrium). This is augmented by additional roentgen irradiation approximating 7 erythema doses.

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TRACHEAL DIVERTICULA

REPORT OF A CASE

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A DIVERTICULUM of the trachea is a rare abnormality which is not without potential serious complications. Kernan[4] reported a case of a two month old infant in whom a tracheal diverticulum had eroded into the innominate artery. Infection of a diverticulum of the trachea may be a source of pulmonary infection; abscess formation and even rupture into the mediastinum are possibilities. By compression or traction the recurrent laryngeal nerve may be paralyzed.[10]

As far back as the Fifth Century, Aetius noted aerial goiters which formed in the neck after parturition. Plater,[7] in the Seventeenth Century, described tracheal diverticula and differentiated them from goiter. In 1846, Rokitansky[8] described the condition and postulated that they resulted from coughing due to chronic pulmonary or bronchial disease. The first case report was presented by Mackenzie[3] in 1911. Diverticula of the trachea, of considerable size, were described in Egyptian minaret criers and in drill sergeants.[10]

The condition unfortunately does not lend itself readily to clinical diagnosis. By far the great majority of cases is discovered at autopsy, although Addington, Rusk and Cohen[1] described a case in which a saccular tracheal diverticulum (5 by 4 by 5 cm.) was diagnosed from a bronchogram. In the differential diagnosis, esophageal diverticulum and tracheal retention cysts must be eliminated. Ziegelman[10] recommends tracheograms after the instillation of iodine in poppyseed oil into the trachea, with the patient in a modified Trendelenburg position.

Tracheal diverticula are of congenital or acquired origin and the latter group may be subdivided into traction or pulsion types. Stibbe[9] believed that the congenital form has a narrow opening, contrasted with the large opening of the acquired form. Chiari[2] thought congenital diverticula are prone to develop at the site where accessory bronchi are most likely to be found. He mentioned Petit's[6] belief that it is possible that the diverticula may be only potential, and that prolonged, increased intratracheal pressure is required to develop them.

In a study of tracheal anatomy, Miller[5] described the trachealis muscle as consisting of transverse bands which unite with the cornua of the cartilage semi-rings. Between these muscle bands are amuscular and relatively weak areas. Except for a reported case in which the patient was found to have a diverticulum due to a rupture of three tracheal semi-rings after a blast explosion, almost all diverticula of the trachea occur on the posterior wall. Undoubtedly, chronic increased intratracheal pressure is an important factor in the production of this condition.

Frequently other pulmonary or bronchial disease is associated, particularly cystic disease of the lung and bronchiectasis. That there may be an inherent susceptibility or weakness of the tracheal wall which, coupled with infection and chronic cough leads to the production of diverticula, is a likely possibility. True congenital diverticula of the trachea are uncommon.

REPORT OF A CASE

H. G., male, aged sixty-six, of Norwegian extraction, was admitted to the Municipal Tuberculosis Sanitarium of Chicago, November 14, 1945. His chief complaints were dyspnea, weakness and a 12 lb. (5.4 kg.) weight loss.

At the age of thirty-three the patient fell against a picket fence with enough force to lead him to believe that a picket pierced his right



FIG. 1. Anteroposterior (*A*) roentgenogram of the chest and bronchogram (*B*), lateral view. The cystic disease of the right lung is well outlined in both films.

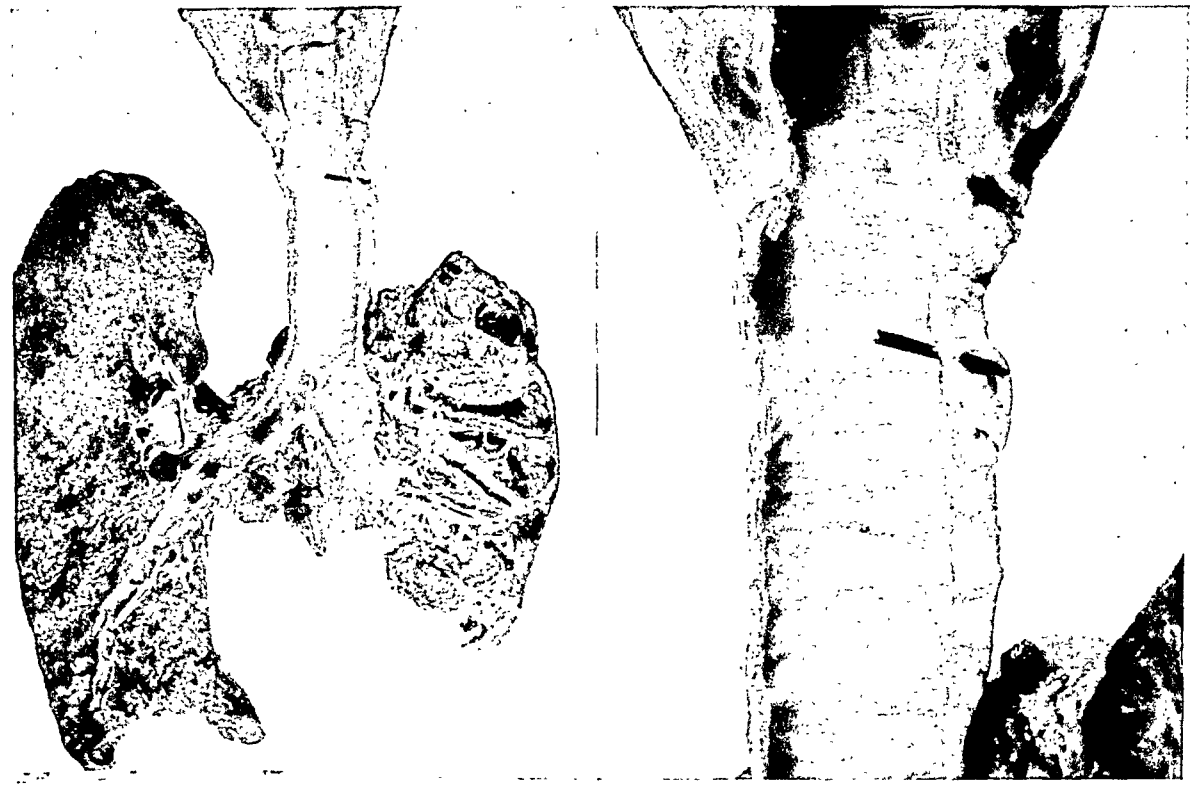


FIG. 2. Photographs of the lungs and trachea after section. The right lung is contracted and cystic. The transversely sectioned diverticulum contains a probe and lies immediately below the smaller diverticulum.

chest wall. Pneumonia developed promptly in the presumably injured lung. The course was protracted and complicated by a considerable pulmonary hemorrhage. He felt well since his recovery until June, 1945, when he began to feel tired, though able to continue his work. In October, 1945, his second pulmonary hemorrhage forced him to rest.

His family history was not significant.

Examination. The patient was 5 ft. 4 in. tall, weighed 102 lb. (46.3 kg.). The pulse was accelerated but regular. The systolic pressure was 130, the diastolic 68, the temperature was 100.6°F. He was dyspneic and pale. The fingers were clubbed; the chest was narrow and asymmetrical with some restriction of movement on the right. In the right upper half there was impaired resonance, amphoric breath sounds and many moist rales; throughout the left chest were many mixed rales. The vital capacity was 900 cc. All other physical findings were normal.

A roentgenogram of the chest showed cavitation in the upper half of the right lung with partial atelectasis in the right base. The heart and mediastinum were shifted to the right. The left lung was normal except for a thickened apical pleura. A bronchogram revealed marked saccular dilatation of the right middle lobe bronchioles.

The hemoglobin was 62 per cent and there were 4.1 million red blood cells. The white blood cell count was 9,100, with a normal differential. The sedimentation rate was 25 mm. in thirty minutes (Cutler). The Mantoux test (1:100 old tuberculin) was positive. The urine contained 200 mg. albumin and a few red cells. Repeated sputum examinations were negative for tubercle bacilli.

After a few days the patient became afebrile and was discharged five weeks after his admission. The diagnosis was cystic disease of the right lung with superimposed, nonspecific infection.

Second Admission. The patient was readmitted on October 24, 1946, complaining of dyspnea, weakness and difficulty in urination. He had been resting at home since his discharge.

Examination. The blood pressure was 120 systolic and 80 diastolic and the temperature 99.8°F. The pulse rate was irregular. In addition to the previous chest findings there was some dullness and rales in the left base. An electrocardiogram disclosed auricular premature systoles. Other laboratory findings were unchanged from those of the previous admission.



Fig. 3 Photomicrographs (15× and 125×) of the diverticulum wall. The epithelium is ciliated columnar and there is a scattered round cell infiltration. Peripheral to the fibrous tissue is a normal mucous gland.

With penicillin therapy (30,000 units every three hours, intramuscularly) he improved and was discharged November 16, 1946.

Final Admission. December 6, 1946. The patient was now markedly dyspneic. On examination the heart sounds were distant and absolutely irregular. The liver extended 5 cm. below the left costal margin and was slightly tender and smooth. Both lungs contained many loud, moist rales in both bases. Cyanosis was marked.

A roentgenogram of the chest showed no

change compared to his previous films. The red and white blood cell counts were unchanged from those of his first admission. Four days before his death the white blood cell count rose to 14,370, with 77 per cent polymorphonuclear leukocytes. The urine contained 100 mg. of albumin and a few red cells. Sputum examinations were persistently negative for tubercle bacilli.

Digitalis therapy was instituted. He became febrile (101°F.), progressively weaker and short of breath. Death occurred December 11, 1946.

Autopsy (two hours after death). The body was that of an emaciated white man about sixty-eight years old. The chest was fairly symmetrical and without evidence of old injuries. The entire right lung was adherent to the chest wall while the left lung was free in the pleural space. Somewhat shrunken, the right lung on section contained many smooth, fibrous walled cysts which ranged from 2 cm. to 10 cm. in diameter. Between these air-filled cysts the lung parenchyma was compressed and minimal in amount. The bronchi were dilated and their walls somewhat thickened. Purulent exudate was minimal.

The left lung was pale and spongy throughout; the bronchial tree was normal. In the apex a 2 cm. fibrous scar was found.

On the right posterolateral aspect of the trachea, 2.5 cm. distally from the larynx and 3 mm. from the cornua of the fourth and fifth cartilage rings respectively were two openings large enough to pass a small probe. Each communicated with an air-filled diverticulum, the first of which measured 0.5 cm. in diameter and 1 cm. in length. The second diverticulum, situated 1 cm. from the first, measured 1 cm. in diameter and 1.5 cm. in length. There were no adhesions and the trachea was otherwise normal.

The heart weighed 300 gm. It was essentially normal except for dilatation of the ventricles, especially the right. The ascending aorta contained numerous, large, yellow plaques.

The spleen weighed 120 gm. The capsule and parenchyma were studded with numerous (3 mm. in diameter) yellow nodules. These contained caseous centers and were well encapsulated.

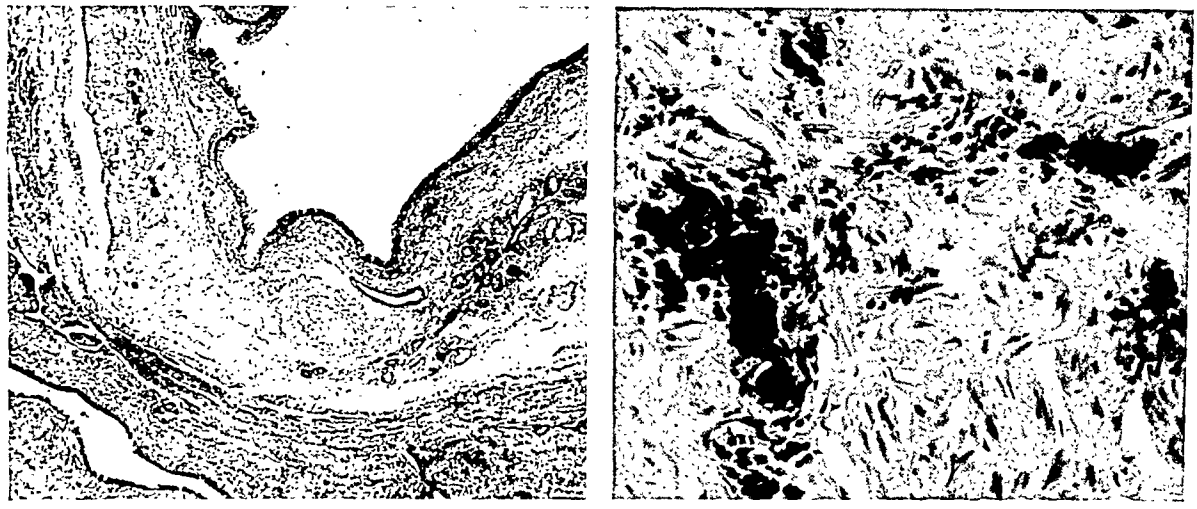


FIG. 4. Photomicrographs (10× and 240×) of a cyst wall and of the moderate anthracosis in the cystic lung. There is an orderly arrangement of cartilage, smooth muscle and mucous glands.

The liver weighed 1,700 gm. It extended 8 cm. below the level of the costal margin. On section the vascular markings were prominent on a yellow background. Four small, yellow nodules were discovered.

The kidneys weighed together 320 gm. They were congested and contained a few thin-walled retention cysts. In the right kidney a 2 mm. firm, yellow nodule was found in the cortex.

The remaining organs showed no significant changes.

Microscopic Examination. The diverticula were lined with stratified columnar, ciliated epithelium which rested on a fairly distinct basement membrane. The submucosa was of loose areolar tissue and, in areas, infiltrated by lymphocytes. The greater part of the wall was

composed of fibrous tissue, at the periphery of which a post-tracheal mucous gland was found. The blood vessels were not remarkable.

In the right lung the epithelium of the cysts ranged from ciliated columnar to stratified squamous. Occasionally a cyst wall was ulcerated and active inflammation was associated. Fibrous hyperplasia was marked. Anthracotic pigment was in considerable quantities. The few alveoli that were spared showed interstitial fibrosis. The bronchi were dilated and in some cysts there was an orderly arrangement of cartilage, smooth muscle, and mucous glands. Many of the cysts communicated with the bronchi. No evidence of malignant change was noted.

Anatomic Diagnosis. 1. Cystic bronchiectasis of the right lung with pleural fibrosis. 2. Tracheal diverticula. 3. Nephrosclerosis. 4. Healed tuberculous lesions of the spleen, liver, kidney and left lung. 5. Emphysema of the left lung. 6. Atherosclerosis of the aorta and coronary vessels. 7. Hypertrophy and dilatation of the right ventricle.

DISCUSSION

It is common to find associated anomalies in congenital cystic disease of the lungs and in this case, because of the tracheal anomalies, the pulmonary cystic disease could be considered as congenital. However, that premise is not well founded. The history of the patient revealed a chest injury followed by pneumonia; in addition, much coal pigment was found throughout the deep tissues where it had lodged when the alveoli were functioning. Whether a hereditary weakness of the bronchial structures was present, or whether a part of the cystic disease was congenital, could not be determined.

SUMMARY

Diverticula of the trachea are rare anomalies which are seldom diagnosed clinically. They may be of congenital or acquired origin and sometimes coexist with chronic pulmonary or bronchial disease. Potential complications are infection, abscess formation, rupture, and pressure (or traction) effects upon the recurrent laryngeal nerve. A case is presented having two tracheal diverticula which were found at autopsy. In the right lung, cystic bronchiectasis was marked and apparently of acquired origin.

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HEMANGIOMA OF THE KIDNEY

ITS ROENTGEN DIAGNOSIS

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HEMANGIOMA of the kidney is a rare lesion; there are less than 50 case reports in the literature. In both its clinical and roentgenologic manifestations, it may closely resemble renal carcinoma. Because of this similarity, it is desirable to emphasize such differentiating points as exist.

Hemangioma occurs in the kidney as an isolated lesion or as a manifestation of a generalized hemangiomatosis. They may be single or multiple. They are of the capillary or cavernous type. They may be located in the cortex, medulla, tip of a papilla or subepithelially in the renal pelvis. The majority are adjacent to the renal pelvis. They may vary in size from a few millimeters to several centimeters in diameter. When the pelvic epithelium is penetrated, hematuria results from rupture of one of the dilated vessels. If rupture of a vessel occurs within the tumor, a blood cyst may result.



FIG. 1. Case 1.

In 85 per cent of the reported cases, the onset of symptoms occurred before the age of forty. This is a distinguishing feature from renal carcinoma—its clinical onset is largely after the age of forty. The most constant symptom is hematuria. This may have been present intermittently for several years. In some cases, it may be so profuse as to require immediate surgery. Colicky pain is present in about 40 per cent of cases. This is usually due to the passage of blood clots. Nephrectomy is usually necessary for cure, though in some cases heminephrectomy has been performed.

The following 2 cases illustrate the salient features of this lesion.

REPORT OF CASES

CASE 1. On March 25, 1946, the patient, a white female, aged forty-nine, had an attack of acute left lumbar pain radiating to the umbilicus, of several minutes' duration. There was an accompanying hematuria. On March 29, 1946, the hematuria recurred. Past history was not relevant. Physical examination was negative. On March 29, cystoscopy revealed bloody urine in the bladder, with normal renal function bilaterally. Left retrograde urography (Fig. 1) revealed pyeloparenchymatous extravasation from the fornix of the left middle calix. The fornix was compressed and elongated as if by a soft tissue mass. The adjacent infundibulum was minimally compressed on its superior aspect. Throughout its distal two-thirds there was a homogeneous filling defect suggestive of blood clot. Lateral view revealed no renal displacement. On April 3, excretory urography (Fig. 2) revealed bilateral good function, with inadequate visualization of the left middle calix. On April 5, 1946, the patient was readmitted to

the Jewish Hospital. Smear and culture of the urine revealed no evidence of tubercle bacilli. Roentgen examination of the chest revealed thickened pleura at the left base.

On April 12, 1946, a left nephrectomy was performed. The kidney measured 10.5 by 2.5 cm. The middle calix was obstructed, with a submucous hemorrhage present in the adjacent pelvis. An angioma measuring 1.2 by 0.9 cm. was demonstrated in the kidney around the middle calix. Microscopic section revealed it to be a cavernous hemangioma impinging upon the

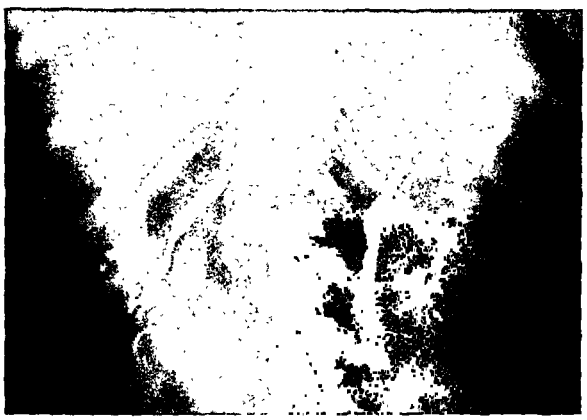


Fig. 2. Case I.

pelvis, and with a fine channel leading from it to the adjacent hyperplastic pelvic epithelium.

Case II. On March 14, 1946, this patient, a female, aged fifty-six, experienced an attack of left lumbar pain, nausea and vomiting, accompanied by the passage of bloody urine. In 1942, a similar episode occurred; she had considered the bleeding vaginal. In 1932, radium sterilization had been performed because of functional uterine bleeding. Physical examination revealed only hypertension with a blood pressure of 190/100.

On March 20, left retrograde urography was performed. It demonstrated (Fig. 3) deformity of the superior major calix. The infundibulum was widened, with a poorly defined defect present through its major portion. The fornix was compressed and elongated. There was increase in the width of the upper pole extracaliceal tissue, indicating the presence of a soft tissue mass. Lateral view revealed no displacement of the kidney. There was the incidental demonstration of increased concavity of one inferior caliceal fornix. On March 25, excretory urography revealed reduced function of the left kidney; right renal function was natural.



Fig. 3. Case II.

On April 5, 1946, a left nephrectomy was performed. The kidney measured 11.5 by 5 by 4 cm. The superior major calix was minimally dilated. A circular soft tissue mass, measuring 1 cm. in maximum diameter, projected into it. This mass contained fluid blood and blood clots, and surrounded a large vessel and numerous smaller vessels. Microscopic section through this mass demonstrated a cavernous hemangioma. In addition, a minute cavernous hemangioma was demonstrated on the surface of the kidney.

DISCUSSION

These 2 cases exhibit striking similarity in roentgen manifestations. In both cases there was evidence of a compressed fornix of a major calix, with deformity of the infundibulum and filling defect throughout its major portion. It is therefore suggested that when these roentgen manifestations are demonstrated in a patient under forty complaining of slight or recurrent episodes of hematuria, accompanied by renal colic,

the diagnosis of renal hemangioma should be strongly considered. It is unsuual that both these patients are over forty years of age. In a percentage of cases, however, early in the development of the lesion, roentgenologic examination is negative. When this occurs in a patient with unexplained hematuria, periodic roentgen examinations are indicated. The lesion may become demonstrable at a later date.

Nephrectomy or heminephrectomy is the treatment of choice.

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CALCIFICATION IN THE OBLITERATED DUCTUS ARTERIOSUS OF AN INFANT*

A VERIFIED EXAMPLE DIAGNOSED BEFORE DEATH

CASE REPORT

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THE roentgenographic demonstration of calcification in the obliterated ductus arteriosus was reported by Childe and MacKenzie[1] in 1945. Their material consisted of 4 cases, 1 discovered at postmortem examination and 3 others in whom chest roentgenograms revealed shadows which were considered to represent calcium in the ductus arteriosus. Unfortunately, in their verified case there had been no roentgenogram of the chest before death, although examination of the heart after removal showed quite dense calcification which should have been readily recognizable during life. The present case is being reported as it represents an example of calcification in an obliterated ductus arterio-

[1] Childe, A. E., and Mackenzie, Eleanor R. Calcification in the ductus arteriosus. Am. J. Roentgenol. & Rad. Therapy, 1945, 54, 370–374.



Fig. 1. Posteroanterior roentgenogram of the chest made shortly before death. The calcified obliterated ductus arteriosus lies close to the point of the arrow opposite the fourth interspace posteriorly.

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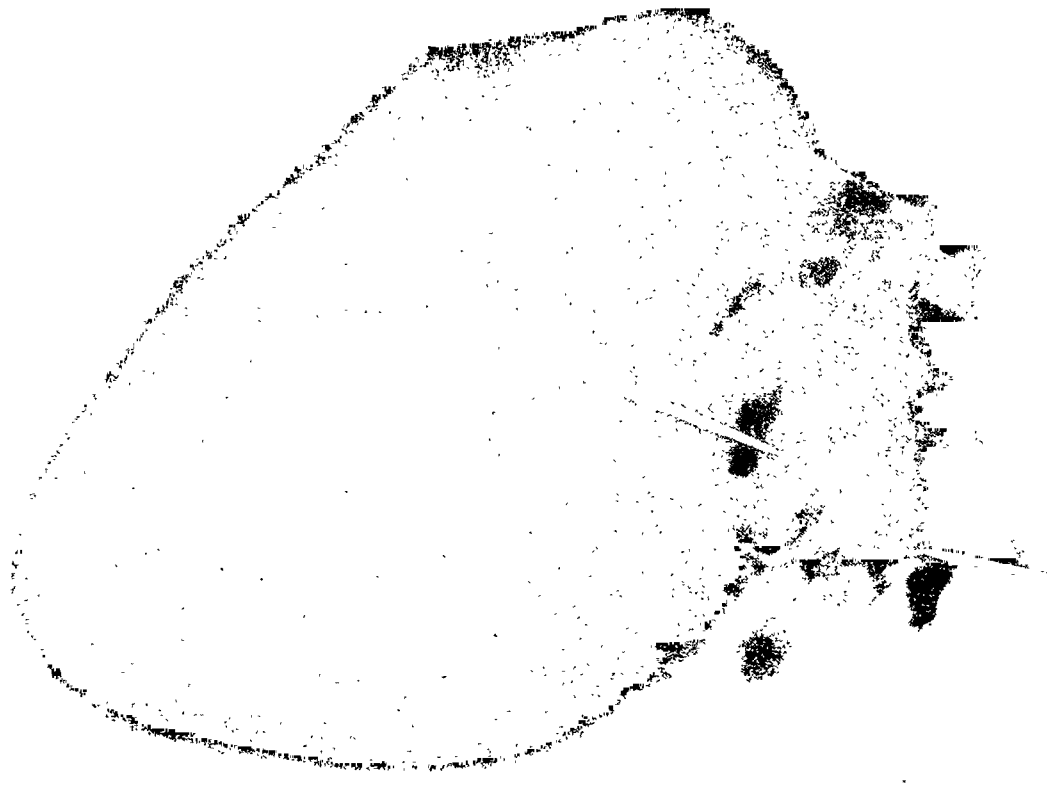


FIG. 2. Removed heart and great vessels. The ductus arteriosus lies between the points of the pins and the calcification can be seen to be chiefly in its aortic half.

sus visible in a roentgenogram of the chest of an infant and verified the same day by postmortem examination.



FIG. 3. Longitudinal section through the ductus arteriosus. The dimple in the pulmonary artery is shown at the lower left and aortic termination at the upper right. (Hematoxylin and eosin ×7.)

CASE REPORT

J. D. (Autopsy No. A-6059). This white female child was first admitted to the Winnipeg General Hospital at the age of fifteen and a half months suffering from severe nutritional anemia. The family background was bad, six other siblings all having suffered from "anemia" in infancy. Her diet had consisted of nothing but an inadequate milk formula plus a few scraps of food from the table. With increased nutrition, small transfusions and iron and liver therapy her erythrocyte count rose from 2.29 to 4.89 million per cu. mm. and her hemoglobin from 29 per cent to 79 per cent in one month. She was readmitted at the age of nineteen months with a history of a "cold" for one month and convulsions for twelve hours. Examination showed her to be comatose. Her neck was not rigid and Kernig's sign was negative. There was some question of blowing breathing in the left lung, and consequently roentgenograms of the chest were made on her way up to the ward. These showed no infiltration in either lung but in the posteroanterior projection there was seen a shadow with the density of calcium

measuring 3 by 1 mm. situated just to the left of the vertebral column opposite the fourth interspace posteriorly (Fig. 1). This was not visible in the lateral view. Nothing otherwise remarkable was noted.

She died two hours after admission and an autopsy the same afternoon showed the cause of death to be pneumococcal meningitis. In view of the roentgenological suggestion of calcification in the ductus arteriosus a careful dissection of the heart and great vessels was made. The ductus was found to be hard and a roentgenogram of the removed specimen confirmed the presence of calcification in this structure (Fig. 2). Microsection through its long axis after partial decalcification showed the lumen to be completely obliterated by fibrous connective tissue containing a small amount of elastic tissue. Scattered through the partially hyalinized connective tissue and chiefly in the aortic half of the ductus there was amorphous granular basophilic staining calcium deposit (Fig. 3 and 4).

SUMMARY

This case report describes an example of calcification in the obliterated ductus arteriosus of an infant nineteen and a half months of age, suspected from a roentgenogram of the chest and verified later at postmortem examination.



Fig. 4. Higher magnification of aortic portion of the ductus arteriosus showing dark staining calcification. Calcium has been dissolved from the irregular spaces during preparation of the specimen. (Hematoxylin and eosin ×30.)

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UNDISTORTED VERTICAL PROJECTIONS OF THE HEAD FROM LATERAL AND POSTERO-ANTERIOR ROENTGENOGRAMS*

By WENDELL L. WYLIE, D.D.S., M.S., *and* W. A. ELSASSER, A.B., D.D.S.†
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THE most precise instrument yet devised for the quantitative study of craniofacial morphology is the Broadbent-Bolton roentgenographic cephalometer. Since it has been adequately described elsewhere in the literature, no extensive review of its design will be given here. The apparatus consists of a head-holding device to maintain the subject's head in the Frankfort plane, and two roentgen-ray heads fixed in relation to the head-holder so that the central ray of one (lateral) passes through both external auditory meati, entering from the right side, with the other (posteroanterior or frontal) at right angles to the central ray of the lateral tube, passing along the intersection of the median sagittal and Frankfort planes of the subject. Rods in the ear-holes and a rest at the bridge of the nose stabilize the patient's head. Appropriate channels are provided for cassettes so that true lateral and frontal views may be taken at right angles to one another.

A factor which must be recognized in all roentgenographic techniques, and particularly those in which quantitative measurements are to be made, is the divergence of the rays as they leave the anode. The Broadbent instrument minimizes the resultant size distortion in the image by having the films as close as possible to the subject's head, and by locating the anode as far as is practicably possible from the subject's head. This does not eliminate size distortion, however, and consequently vernier scales are provided whereby one may read to one-tenth of a millimeter the distance from the median sagittal plane to the lateral film, and the distance from the posteroanterior film to the ear-rod axis. Since the distance from the median sagittal plane to the lateral anode and the distance from the ear-rod axis to the posteroanterior anode is exactly 5 feet, all necessary values are known for accurate computation of true dimensions from the distorted ones in the films, using the method of similar triangles.

In the decade and a half in which the Broadbent cephalometer has been used, the lateral head film has received more attention than has the frontal. This reflects not only primary interests of investigators, but also the fact that problems of size distortion in the lateral view are inconsequential enough that they may usually be ignored. This is not true of the frontal, however, and it seems safe to say that if an acceptable method for correcting for size distortion were available for use with the frontal view that *norma frontalis* might then receive some of the attention that has been lavished in the past upon *norma lateralis*. In the lateral film, bilaterally situated structures are superposed upon one another, and one may adopt the convention that they lie in the median sagittal plane; furthermore, the

* From the Division of Orthodontics, College of Dentistry, University of California. Presented at the International Association for Dental Research, June 21, 1947.

† Associate Professor and Chairman of the Division of Orthodontics, and Instructor in Orthodontics, respectively.

head increases little in width in postnatal growth, so that the distance from lateral film to the median sagittal plane does not increase to such an extent as does the distance from the ear-rod axis to the frontal film. Increases of this sort tend to increase object-film distance, which materially increases the degree of size distortion.

in reality a specialized drawing board and T-square, modified from the familiar prototypes to reproduce roentgen-ray paths, i.e., radii of a sphere, instead of parallel lines.

The compensator consists of two parts, a bedplate and a slider (Fig. 1). The bedplate is the equivalent of the drawing board

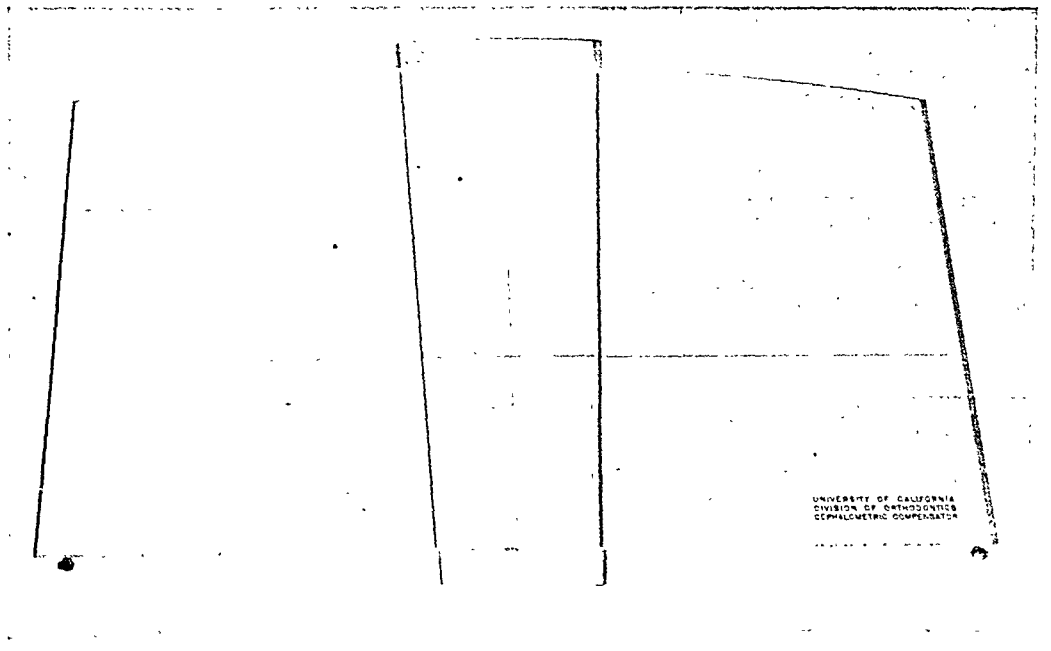


Fig. 1. The "compensator" without millimeter paper taped to the bedplate. The two engraved lines represent the axes of orientation in the Broadbent cephalometric technique; the slider traverses the curved border of the bedplate so that its edges always reproduce paths of roentgen rays.

While it is possible to make any correction desired by calculation, considerable ingenuity has been expended in efforts to provide some more convenient way of accomplishing it. The most straightforward method so far offered is that of Adams, in which he made roentgenograms of a leaded millimeter rule at progressively greater object-image distances, so that one might measure directly upon the lateral film, using a scale which was distorted to the same extent as was the image of the subject. This relies heavily upon the assumption that structures seen in *norma lateralis* are projections to the median sagittal plane, and efforts to use this method with the frontal film were less rewarding.

Our device called the "compensator" is

and is made of $\frac{1}{4}$ inch lucite. Two of the sides are parallel and at right angles to a a third side. On it are engraved two lines, one parallel to the long lower edge of the bedplate and the other parallel to the two short sides. These lines intersect at right angles in the center of the bedplate. The fourth or upper edge of the bedplate is curved and is an arc whose center is exactly 5 feet from the intersection of the engraved lines. The slider is cut to fit the curved border exactly and finished to slide smoothly along it so that it may be brought to any position on the arc. The long edges of the slider reproduce radii of the arc, regardless of the position of the slider on the arc.

In describing the use of the compensator,

we must make it clear that the films themselves are not put directly upon the bedplate for viewing; they are measured independently and the measurements themselves are taken to the compensator. Millimeter paper is taped to the bedplate so that the lines on it coincide exactly with the engraved lines. To simplify description, let us determine the true distance across the angles of the jaw. The vernier reading gives the exact distance which the film lay from the porionic axis when taken. This film plane is reproduced on the millimeter paper by a line drawn parallel to the engraved line on the compensator corresponding to the porionic axis (the longer of the two lines), and at a distance from it indicated by the vernier reading (Fig. 1). On this line the angles of the jaw are laid off as taken from the frontal film, keeping each in its proper relation to the median plane as represented by the other engraved line. The bigonial width so laid off is enlarged because of ray divergence, and must be corrected. We then bring the slider to position so that one edge lies on one point, and extend a fine line back towards the center. Since the rays which produced these images on the film traveled in straight lines as radii from the anode, the true gonial points must lie somewhere along these lines. It is a simple matter to determine precisely where they belong, using Adams' scales to measure along the Frankfort horizontal on the lateral film. To determine the true bigonial distance, measure between the two points thus established.

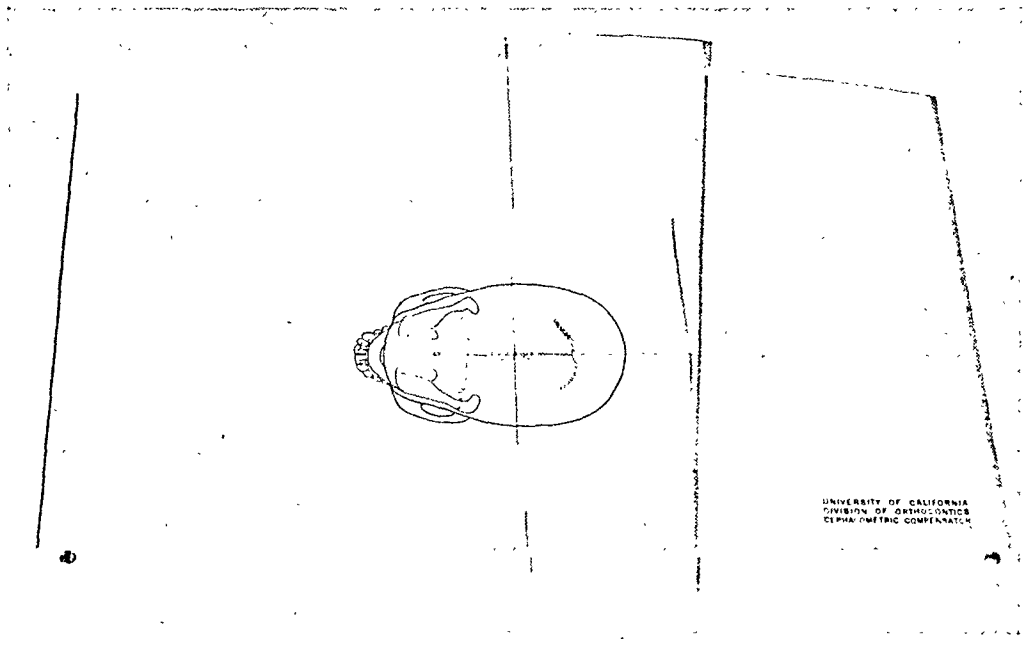


FIG. 2. Illustrating how a vertical projection of the face and cranium is created on the compensator from lateral and posteroanterior films. Unlike the images on the two films, this basal "view" is not distorted.

One will readily see that, having located these true points on the millimeter paper, we may not only measure the distance accurately between them, but we may locate a variety of other points on the paper, thus producing a third view of the skull seen at right angles to the other two, with all size distortion eliminated. This has been represented in Figure 2, but the orientation has been deliberately changed to show how the compensator may be used to correct the lateral film, so as to obtain true measurements of craniofacial depth, i.e., greatest head length, over-all jaw length, length of anterior or posterior cranial base, and so forth.

The principle described here may be put to use in techniques other than the Broadbent one to obtain quantitative values

from roentgenograms, eliminating the element of distortion introduced by the divergence of rays. This would require, of course, the construction of a compensator with an arc and slider cut to correspond with the target distance used in the particular technique. The technician chosen to do the work should be made to understand that the device is worthless unless it is made very accurately.*

SUMMARY

A simple device is described whereby one may correct for size distortion in roentgenograms, and which may be used to create a third vertical projection of the cranium when one has oriented lateral and posteroanterior roentgenograms. This vertical projection is created on millimeter paper with all distortion due to ray divergence eliminated. Incidentally, the device is a useful teaching aid in illustrating the amount of distortion inherent in a given anode-object distance when object-film distance is varied.

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* Fabrication by Plastic Productions, 809 Mission Street, San Francisco, Calif.

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Thirty-first Annual Meeting: 1949, to be announced.

EDITORIALS

HYDROTHORAX IN CONGESTIVE HEART FAILURE

OUR clinical as well as roentgenological impressions concerning the frequency of manifestation of a certain pathological finding may be in error. For a long time there has been an impression that right hydrothorax is seen much more frequently than left hydrothorax in congestive heart failure.

McPeak and Levine[1] have recently analyzed a group of cases exhibiting congestive heart failure with hydrothorax. In order to make their analysis more significant they included only those cases suffering from clear cut cardiovascular disease with congestive heart failure. They grouped their cases under three general headings: Those exhibiting hydrothorax in congestive heart failure as shown by clinical signs and thoracentesis, and second, those exhibiting hydrothorax in congestive heart failure as shown in the roentgenological examination, and third, cases of congestive heart failure exhibiting hydrothorax at postmortem examination.

Their observations and studies led them to believe that their general impression was correct in regard to the distribution of hydrothorax in congestive heart failure and that "from whatever angle an analysis is attempted, regardless of the method of approach or the underlying cardiac condition, the combination of factors which determine the transudation of fluid into the pleural sacs exerts an influence in such a manner as predominantly to involve the right pleura. This influence, however, appears to be augmented in rheumatic heart conditions as compared to those in which failure of the left heart is more frequently encountered."

Numerous attempts have been made to explain the distribution of hydrothorax which occurs in the course of congestive heart failure, and McPeak and Levine were impressed by the fact that the subject has been approached from isolated points of view which have led to an over-emphasis of some particular factor involved, and there is a tendency toward over-simplification of the problem as a whole. They call attention to Baccelli's early work in 1867 in which he advanced the azygos theory to explain the comparative frequency of right hydrothorax, assuming that pleural fluid accumulated through disturbance in the systemic circulation and for a long time these views of Baccelli were accepted without question. However, some recent observers reporting on the more frequent occurrence of right hydrothorax explained the phenomenon by the fact that the pressure on the root of the right lung and azygos vein by an enlarged right auricle could be an explanation for a predominance of right hydrothorax, and that the site of the hydrothorax was associated with a corresponding enlargement of the right or the left side of the heart.

Other observers (Fetterhoff and Landis) presented evidence that "transudation of fluid into the pleural sacs took place from the visceral rather than the parietal layer and therefore depended upon involvement of the pulmonary instead of the systemic circulation." They were of the opinion that pressure on the right or left pulmonary veins, by a dilated right or left auricle respectively, determined the location of the pleural transudate, and since the right auricle was more easily and consequently more commonly dilated than the left, a predominance of right hydrothorax might be expected.

Other observers have presented some experimental data demonstrating a greater relative degree of pressure negativity in the

[1] McPeak, E. M., and Levine, S. A. The preponderance of right hydrothorax in congestive heart failure. *Ann. Int. Med.*, 1946, *25*, 916–927.

right pleural space, as compared to that in the left, in normal individuals, and as a result of this difference would explain the prevailing tendency toward preponderance of right hydrothorax.

Dock in 1935 presented what appeared to be convincing evidence that the anatomic and hydrostatic factors relating to the flow of blood from the pulmonary venous bed to the left ventricle strongly favored the predominance of right over left hydrothorax. He further emphasized these factors as being considerably augmented by the right lateral decubital position which cardiac patients generally prefer.

It may easily be seen that these various conjectures and observations concerning the systemic and pulmonary circulations in the pathogenesis of cardiac hydrothorax have led to much speculation and controversy. Drinker in his epoch-making contribution to pulmonary edema and inflammation stated, "It is generally acknowledged that two factors are fundamental in causing transudation in the lungs and pleural sacs. They are, first, sustained increase in pulmonary pressure, and second, anoxia—while one or the other may be dominant in a given case, they never, in my opinion, work alone. And from his studies and deductions he further stated, "It is my belief, I cannot say conviction—that simple pulmonary edema and the more serious pulmonary exudations depend more upon alterations in the permeability of lung capillaries than upon complicated pressure relations in the pulmonary circulation."

McPeak and Levine while accepting the view that the visceral pleura is the principal source of abnormal collection of fluid within the pleural sacs, and owing to their peculiar environment, their increased susceptibility to anoxia, and the inadequacy of pulmonary lymph flow under stress, that the pulmonary capillaries are particularly susceptible to the forces promoting transudation, there are yet to be considered a number of anatomical and physiological factors which may determine, modify or tend to localize such a process. These observers call attention to the fact that an explanation of the preponderance of right hydrothorax may pertain to the lungs themselves. They point out the fact that the right lung is some 10 per cent greater in volume than the left and when one considers the extra lobe of the right, the disproportion between the areas of visceral pleura on the two sides of the chest is even greater, and any factor which tends to limit respiratory excursion such as hypostasis, hepatic engorgement, cardiac enlargement, etc., tears down the natural defenses against the consequences of local increased capillary transudation.

They cite the experiments of Warren, Peterson and Drinker which showed that pulmonary lymphatic drainage takes place almost entirely through the right lymphatic duct with limited anastomosis to the thoracic duct. McPeak and Levine make the query as to what effect this might have on the lungs individually when lymphatic stasis occurs and whether the left lung receives greater benefit from the collateral drainage. They call attention to a rather important observation, namely, that it is much more difficult to form an impression as to the relative importance of the parts played by the visceral and parietal pleurae in absorption of fluid, and that little experimental work seems to have been done on which to base an opinion.

McPeak and Levine have established from an analysis of their cases that right-sided hydrothorax is much more frequent in congestive heart failure, but the causative factors which bring about this phenomenon are not readily understood. Various theories have been advanced to explain this phenomenon, none of which seem wholly adequate or satisfactory. Herein lies an opportunity for well planned research and investigation employing the roentgen ray as an adjuvant, and the recent splendid work of Macklin[2] offers a clue that will furnish a point of departure for the investigation of congestive heart failure in general and particularly the hydrothorax which so frequently accompanies it.

[2] Macklin, C. C. Terminal pulmonary venules in mammalian lungs. *Tr. Roy. Soc. Canada* (Sect. V, Biol. Sc.), 1945, *39*, 105–129. Also, Respiratory volume changes in the pulmonary blood vessels in relation to artificial relaxation therapy. *Dis. of Chest*, 1948, *14*, 534.



Srauss Peyton, Kansas City

LEWIS G. ALLEN
1891-1948

DR. LEWIS G. ALLEN, a member of the American Roentgen Ray Society since 1936 and a Past-President of the Radiological Society of North America, died in Providence Hospital, Kansas City, Kansas, on May 28, 1948.

Born in Lenexa, Kansas, in 1891, Dr. Allen was graduated from the University of Kansas School of Medicine. He served an internship at St. Joseph Hospital, Kansas City, Missouri, and at the Royal Victoria Hospital, Montreal, Canada, the latter being interrupted by his entrance into the United States Army in World

War I. Assigned to the Kansas City School of Military Roentgenology, he was with the A.E.F. as a member of Base Hospital No. 116 and Mobile Hospital No. 9.

Dr. Allen was radiologist to Bethany, Providence, and St. Margaret's Hospitals, Kansas City, Kansas, and Professor of Clinical Roentgenology at the University of Kansas School of Medicine. Dr. Allen did not limit his activities to radiology, but took a lively interest in organized medicine. He was a Fellow of the American College of Physicians, and for many years was active in the affairs of the Kansas State Medical Society. He also served as President of the Wyandotte County Medical Society, and President of the Kansas City Southwest Clinical Society. He was an honorary member of the Kansas City Academy of Medicine, and he was active in various committees and an energetic participant in local and national radiological organizations. He always demonstrated his willingness to assume responsibility and his ability to work diligently and with originality in the discharge of his duties. His was the task of formulating the plans and executing the details of the first Refresher Courses presented by the Radiological Society of North America, an undertaking which those who have had the opportunity of working with him know to have been an exacting one.

Civic affairs always claimed a great deal of Dr. Allen's time and attention. To the end he served as Chief of the Emergency Medical Service under the Civilian Defense Program for Kansas City, Kansas. He was a charter member and an active participant in the Kiwanis Club, a trustee of Group Hospital Service, Incorporated, and a member of the Board of Directors of Blue Shield.

Dr. Allen contributed numerous articles to the radiological literature and he always took an active part in the programs of medical organizations to which he belonged.

He was a sincere and loyal friend, who will be greatly missed by all his colleagues.

IRA H. LOCKWOOD, M.D.



EDWIN LOUIS RYPINS
1903 1948

DR. EDWIN LOUIS RYPINS died on July 4, 1948, at Brokaw Hospital, Normal, Illinois. The cause of his death was skull fracture, the result of an automobile accident late Thursday afternoon, July 1. Dr. Rypins was returning from a consultation at the Veterans Facility, Dwight, Illinois, when his car was struck by a motorist who had failed to stop for an entering stop sign. He never regained consciousness.

Dr. Rypins was born in Omaha, Nebraska, on January 8, 1903, the son of Max and Natalie Rypins. He was graduated with a Bachelor of Science degree from the University of Nebraska in 1925

and from the University of Nebraska Graduate School in Medicine in 1927. His internship was served in Scranton State Hospital of Pennsylvania 1927 to 1928 and a residency in medicine was completed in Ridley Park Hospital of Pennsylvania from 1928 to 1929. Dr. Rypins engaged in general practice in Chester, Pennsylvania, 1929 to 1930. He entered the Department of Radiology for postgraduate work in radiology at Iowa State Hospital under Dr. H. Dabney Kerr in 1930 and continued his training through 1935.

In 1933 Dr. Rypins was married to Miss Martha Cannon, who survives him.

From 1936 to 1942, he engaged in the practice of radiology in Bloomington, Illinois and was appointed director of the radiological department at Brokaw Hospital, Normal, Illinois, where he served until 1942.

Dr. Rypins enlisted in the Army of the United States September 10, 1942, with the rank of Major, was promoted to the rank of Lieutenant-Colonel in January, 1945, which rank he held until the time of his discharge, October 24, 1946. His service connected activities included assignments to medical units in Louisiana and Texas from September, 1942 to March, 1943. He then served as chief of the X-ray department of the 69th General Hospital in Ledo-Assam, China, Burma and Indian Theatre and also served with the 233rd and the 9th General Hospitals on Okinawa and with the 4th and 248th General Hospitals in Manila as chief of the department. Dr. Rypins received the European Theatre Ribbon and the Asiatic-Pacific Medal with battle stars and the World War II Victory Medal and the Japan Occupation Clasp.

Following his discharge from the armed service, he returned to Bloomington and re-established his private practice and continued the directorship of the radiological department, Brokaw Hospital, Normal, Illinois and was appointed a consultant to the Veterans Facility, Dwight, Illinois.

Dr. Rypins held membership in the American Legion and the Reserve Officers Corps. He was a member of the McLean County Medical Society, the Illinois State Medical Society, where he served as Secretary of the Section on Radiology in 1948, the Illinois Radiological Society, Fellow in the American College of Radiology, American Roentgen Ray Society, Radiological Society of North America and was certified by the American Board of Radiology.

Dr. Rypins will be missed by his associates in the medical profession in Bloomington and Normal, all of whom, together with his many friends, will, with deep affection and inspiration, remember him for his judgment, his undeviating intellectual honesty, his keen wit and scientific understanding and his deep appreciation for a job well done.

E. M. STEVENSON, M.D.



EDWIN S. FLARSHEIM
1894-1948

IT IS with sincere regret that we report the death on June 29, 1948, of Edwin S. Flarsheim, one of the founders of The Liebel-Flarsheim Company, Cincinnati, Ohio.

Mr. Flarsheim's death followed a long illness which had, for some years, prevented his active participation in the business which bears his name. However, his engineering genius was well known throughout the world, and his contributions to the electro-medical field will serve as a lasting tribute to his memory. To him goes the credit for the development of the great majority of roentgen-ray, electrosurgical, and electromedical equipment made by The

Liebel-Flarsheim Company for doctors, surgeons, and hospitals in all parts of the world.

Mr. Flarsheim was born in Louisville, Kentucky, on January 7, 1894. He attended Manual Training High School at Louisville, where he won high scholastic honors. Later, he graduated as top-honor engineering student from Rose Polytechnic Institute. Shortly after his graduation from Rose Polytechnic, Mr. Flarsheim joined with Mr. G. H. Liebel in 1917 to form The Liebel-Flarsheim Company. He developed the Bovie Electrosurgical Unit, L-F X-Ray Timers, L-F Potter-Bucky Diaphragms, Short-Wave Diathermy Units and many other valuable contributions to medical science.

Mr. Flarsheim's concept of human relations enabled him to develop and maintain a spirit of cooperative friendliness within the Liebel-Flarsheim organization.

SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

Items for this section solicited promptly after the events to which they refer

MEETINGS OF ROENTGEN SOCIETIES*

United States of America

American Roentgen Ray Society
Secretary, Dr. H. Dabney Kerr, University Hospital, Iowa City, Iowa. Annual meeting: Palmer House, Chicago, Ill., Sept. 14–17, 1948.

American Radium Society
Secretary, Dr. H. F. Hare, 605 Commonwealth Ave., Boston, Mass. Annual meeting: 1949, to be announced.

Radiological Society of North America
Secretary, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N. Y. Annual meeting: Hotels Fairmont and Mark Hopkins. San Francisco, Calif., Dec. 5–10, 1948.

American College of Radiology
Secretary, Mac F. Cahal, 20 N. Wacker Drive, Chicago 6. Annual meeting: 1949, to be announced.

Section on Radiology, American Medical Association
Secretary, Dr. U. V. Portmann, Cleveland Clinic, Cleveland, Ohio, Annual Meeting: 1949, to be announced.

Alabama Radiological Society
Secretary, Dr. C. S. Stickley, 515 Bell Bldg., Montgomery, Ala. Next meeting time and place of Alabama State Medical Association.

Arkansas Radiological Society
Secretary, Dr. Fred Hames, 511 National Bldg., Pine Bluff, Ark. Meets every three months and also at time and place of State Medical Association.

Brooklyn Roentgen Ray Society
Secretary, Dr. A. H. Levy, 1354 Carroll St., Brooklyn 13, N. Y. Meets monthly on fourth Tuesday, October to April.

Buffalo Radiological Society
Secretary, Dr. Mario C. Gian, 610 Niagara St., Buffalo, N. Y. Meets second Monday evening each month, October to May inclusive.

Central New York Roentgen Ray Society
Secretary, Dr. Dwight V. Needham, 608 E. Genesee St., Syracuse, N. Y. Three meetings a year January, May, November.

Central Ohio Radiological Society
Secretary, Dr. Paul D. Meyer, Grant Hospital, Columbus, Ohio. Meets at 6:30 P.M. on second Thursday of October, December, February, April, and June at Seneca Hotel, Columbus, Ohio.

Chicago Roentgen Society
Secretary, Dr. John H. Gilmore, 720 N. Michigan Ave., Chicago 11, Ill. Meets second Thursday of each month October to April inclusive at the Palmer House.

Cincinnati Radiological Society
Secretary, Dr. Eugene L. Saenger, 735 Doctors Bldg., Cincinnati 2, Ohio. Meets last Monday of each month, September to May, inclusive.

Cleveland Radiological Society
Secretary, Dr. George L. Sackett, 10515 Carnegie Ave. Cleveland 6, Ohio. Meetings at 6:30 P.M. on fourth Monday of each month from October to April.

Dallas-Fort Worth Roentgen Study Club
Secretary, Dr. X. R. Hyde, Medical Arts Bldg., Fort Worth, Texas. Meets in Dallas on odd months and in Fort Worth on even months, on third Monday, 7:30 P.M.

Denver Radiological Club
Secretary, Dr. Mark S. Donovan, 306 Majestic Bldg., Denver 2, Colo. Meets third Friday of each month at Department of Radiology, Colorado School of Medicine.

Detroit Roentgen Ray and Radium Society
Secretary, Dr. E. R. Witwer, Harper Hospital. Meets monthly on first Thursday from October to May, at Wayne County Medical Society Building.

Florida Radiological Society
Secretary, Dr. F. K. Hurt, Riverside Hospital, Jacksonville, Fla. Meets twice annually, in the spring with the annual State Society meeting, and in the fall.

Georgia Radiological Society
Secretary, Dr. Robert Drane, DeRenne Apartments, Savannah, Ga. Meets in mid-winter and at annual meeting of Medical Association of Georgia in the spring.

Houston X-Ray Club
Secretary, Dr. Curtis H. Burge, 3020 San Jacinto St., Houston 4, Texas. Meets fourth Monday each month.

Radiological Society of Kansas City
Secretary, Dr. Arthur B. Smith, 800 Argyle Bldg., Kansas City, Mo. Meets third Thursday of each month.

Illinois Radiological Society
Secretary, Dr. Wm. DeHollander, St. John's Hospital, Springfield, Ill. Meets three times a year.

Indiana Roentgen Society
Secretary, Dr. J. A. Campbell, Indiana University Hospitals, Indianapolis 7. Meets second Sunday in May.

Iowa X-Ray Club
Secretary, Dr. Arthur W. Erskine, 326 Higley Bldg., Cedar Rapids, Iowa. Luncheon and business meeting during annual session of Iowa State Medical Society. Special meetings by announcement.

Kansas Radiological Society
Secretary, Dr. Anthony F. Rossitto, Wichita Hospital, Wichita, Kansas. Meets annually with the State Medical Society.

Kentucky Radiological Society
Secretary, Dr. W. C. Martin, 321 W. Broadway, Louisville. Meets annually in Louisville on first Saturday in Apr.

Long Island Radiological Society
Secretary, Dr. Marcus Wiener, 1430-48th St., Brooklyn, N. Y. Meets Kings County Med. Soc. Bldg. monthly on fourth Thursday, October to May, 8:45 P.M.

Los Angeles Radiological Society
Secretary, Dr. Moris Horwitz, 441 No. Camden Drive, Beverly Hills, Calif. Meets second Wednesday each month at Los Angeles County Medical Assn. Building.

Louisiana Radiological Society
Secretary, Dr. J. R. Anderson, 1130 Louisiana Ave., Shreveport. Meets annually during Louisiana State Medical Society Meeting.

Louisville Radiological Society
Secretary, Dr. E. L. Pirkey, Louisville General Hospital, Louisville 2, Ky. Meets monthly on second Friday at Louisville General Hospital.

Michigan Association of Roentgenologists
Secretary, Dr. R. D. McDuff, 220 Genesee Bank Bldg., Flint 3, Mich.

Milwaukee Roentgen Ray Society
Secretary, Dr. C. A. H. Fortier, 231 W. Wisconsin Ave.,

* Secretaries of societies not here listed are requested to send the necessary information to the Editor.

Milwaukee, Wis. Meets monthly on second Monday at University Club.

Minnesota Radiological Society
Secretary, Dr. Chauncey N. Borman, 802 Medical Arts Bldg., Minneapolis 2, Minn. Two meetings yearly, one at time of Minnesota State Medical Association the other in the fall.

Nebraska Radiological Society
Secretary, Dr. Ralph C. Moore, Nebraska Methodist Hospital, Omaha 3, Nebr. Meets third Wednesday of each month, at 6 P.M. at either Omaha or Lincoln.

New England Roentgen Ray Society
Secretary, Dr. George Levene, Massachusetts Memorial Hospitals, Boston, Mass. Meets monthly on third Friday, Boston Medical Library.

New Hampshire Roentgen Ray Society
Secretary, Dr. A. C. Johnston, Elliott Community Hospital, Keene, N. H. Meets four to six times yearly.

New York Roentgen Society
Secretary, Dr. Ramsay Spillman, 115 East 61st St., New York City. Meets monthly on third Monday, New York Academy of Medicine, at 8:30 P.M.

North Carolina Radiological Society
Secretary, Dr. J. E. Hemphill, 323 Professional Bldg., Charlotte 2, N. C. Meets in May and October.

North Dakota Radiological Society
Secretary, Dr. C. O. Heilman, 807 Broadway, Fargo. Meetings held by announcement.

Northern California Radiological Club
Secretary, Dr. C. E. Grayson, Medico-Dental Bldg., Sacramento 14, Calif. Meets at dinner last Monday, every second month, except June, July and August. Next meeting Sept. 27, 1948.

Ohio State Radiological Society
Secretary, Dr. Carroll C. Dundon, 2065 Adelbert Road, Cleveland 6, Ohio.

Oklahoma State Radiological Society
Secretary, Dr. W. E. Brown, Tulsa, Okla. Three regular meetings annually.

Oregon Radiological Society
Secretary, Dr. William Y. Burton, 242 Medical Arts Bldg., Portland 5, Oregon. Meets monthly 2nd Wednesday, 8:00 P.M., Library of University of Oregon Medical School.

Orleans Parish Radiological Society
Secretary, Dr. Joseph V. Schlosser, Charity Hospital, New Orleans 13, La. Meets first Tuesday of each month.

Pacific Northwest Radiological Society
Secretary, Dr. S. J. Hawley, 1320 Madison St., Seattle 4, Wash. Meets annually in May.

Pacific Roentgen Society
Secretary, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association.

Pennsylvania Radiological Society
Secretary, Dr. J. M. Converse, 416 Pine St., Williamsport.

Philadelphia Roentgen Ray Society
Secretary, Dr. Arthur Finkelstein, Graduate Hospital, 19th and Lombard St. Meets first Thursday each month October to May, at 8:00 P.M., in Thomson Hall, College of Physicians.

Pittsburgh Roentgen Society
Secretary, Dr. R. P. Meader, 4002 Jenkins Arcade Pittsburgh 22, Pa. Meets 6:30 P.M. at Webster Hall Hotel on second Wednesday each month, October to May inclusive.

Queens Roentgen Ray Society
Secretary, Dr. J. E. Goldstein, 88-29 163rd St., Jamaica 3, N. Y. Meets fourth Monday of each month except during the summer.

Radiological Section, Baltimore Medical Society
Secretary, Dr. Harry A. Miller, 2452 Eutaw Place, Baltimore. Meets third Tuesday each month, September to May.

Radiological Section, Connecticut Medical Society
Secretary, Dr. Robert M. Lowman, Grace-New Haven Community Hospital, New Haven 11. Meets bimonthly second Thursday, at place selected by Secretary.

Radiological Section, District of Columbia Medical Society
Secretary, Dr. A. A. J. Den, 1801 K St., N. W., Washington, D. C. Meets Medical Society Auditorium, third Thursday, January, March, May, October at 8:00 P.M.

Radiological Section, Southern Medical Association
Secretary, Dr. Roy G. Giles, Temple, Texas.

Radiological Society of New Jersey
Secretary, Dr. Raphael Pomeranz, 31 Lincoln Park, Newark, N. J. Meets annually at time and place of State Medical Society. Mid-year meetings at place chosen by president.

Rochester Roentgen Ray Society, Rochester, N. Y.
Secretary, Dr. Murray P. George, Strong Memorial Hospital. Meets monthly on third Monday from October to May, inclusive, 8 P.M. at Strong Memorial Hospital.

Rocky Mountain Radiological Society
Secretary, Dr. Maurice D. Frazer, 1037 Stuart Bldg., Lincoln, Nebr.

St. Louis Society of Radiologists
Secretary, Dr. Edwin C. Ernst, Beaumont Medical Building, St. Louis, Mo. Meets fourth Wednesday of each month, except June, July, August, and September.

San Diego Roentgen Society
Secretary, Dr. R. F. Niehaus, 1831 Fourth Ave., San Diego, Calif. Meets monthly, first Wednesday at dinner.

Section on Radiology, California Medical Association
Secretary, Dr. D. R. MacColl, 2007 Wilshire Blvd., Los Angeles 5, Calif.

Section on Radiology, Illinois State Medical Society
Secretary, Dr. Edwin L. Rypins, 427 N. Main St., Bloomington, Ill.

Shreveport Radiological Club
Secretary, Dr. R. W. Cooper, Charity Hospital, Shreveport, La. Meets monthly on third Wednesday, at 7:30 P.M., September to May inclusive.

South Carolina X-Ray Society
Secretary, Dr. T. A. Pitts, Baptist Hospital, Columbia, S. C. Meets in Charleston on first Thursday in November, also at the time and place of South Carolina State Medical Association.

Tennessee Radiological Society
Secretary, Dr. J. M. Frère, 707 Walnut St., Chattanooga, Tenn. Meets annually at the time and place of the Tennessee State Medical Association.

Texas Radiological Society
Secretary, Dr. R. P. O'Bannon, 650 Fifth Ave., Fort Worth 4, Texas.

University of Michigan Department of Roentgenology Staff Meeting
Meets each Monday evening from September to June, at 7 P.M. at University Hospital.

University of Wisconsin Radiological Conference
Secretary, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis. Meets first and third Thursdays 4:00 to 5:00 P.M., September to May inclusive. Room 203, Service Memorial Institute, 426 N. Charter St., Madison.

Utah Radiological Conference
Secretary, Dr. Henry H. Lerner, School of Medicine, University of Utah, Salt Lake City 1. Meets 1st and 3rd Thursdays monthly from 7:30 to 10 P.M., Salt Lake County General Hospital, September to June.

Utah State Radiological Society
Secretary, Dr. M. Lowry Allen, Judge Bldg., Salt Lake City 1, Utah. Meets third Wednesday in September, November, January, March and May.

Virginia Radiological Society
Secretary, Dr. P. B. Parsons, Norfolk General Hospital, Norfolk, Va. Meets annually in October.

Washington State Radiological Society
Secretary, Dr. Homer V. Hartzell, 310 Stimson Bldg., Seattle 1, Wash. Meets fourth Monday each month, October through May, College Club, Seattle.

X-Ray Study Club of San Francisco
Secretary, Dr. Ivan J. Miller, 49 Fourth St., San Francisco 3. Meets monthly on third Thursday at 7:45 P.M., January to June at Lane Hall, Stanford University Hospital, and July to December at Langley Porter Clinic, University of California Hospital.

Cuba

Sociedad de Radiología y Fisioterapia de Cuba
President, Dr. J. Manuel Viamonte, Hospital Mercedes, Habana, Cuba. Meets monthly in Habana.

Mexico

Sociedad Mexicana de Radiologia y Fisioterapia
General Secretary, Dr. D. P. Cossio, Marsella No. 11, Mexico, D. F. Meets first Monday of each month.

British Empire

British Institute of Radiology Incorporated with the Roentgen Society
Medical Members' meeting held monthly on third Friday at 2:30 p.m. and Ordinary Meeting at same time on following Saturday, October to May, 32 Welbeck St., London, W.1.

Faculty of Radiologists
Secretary, Dr. M. H. Jupe, 23 Welbeck St., London, W.1 England.

Section of Radiology of the Royal Society of Medicine (Confined to Medical Members)
Meets third Friday each month at 4:45 p.m. at the Royal Society of Medicine, 1 Wimpole St., London.

Canadian Association of Radiologists
Honorary Secretary, Dr. E. M. Crawford, 2100 Marlowe Ave., Montreal 28, Que. Meetings January and June.

Section of Radiology, Canadian Medical Association
Secretary, Dr. C. M. Jones, Inglis St., Ext. Halifax, N. S.

Société Canadienne-Francaise d'Electrologie et de Radiologie Médicales
Secretary, Dr. Origéne Dufresne, 4120 Ontario St., East, Montreal, P. Q.

Australian and New Zealand Association of Radiologists
Honorary Secretary, Dr. Alan R. Colwell, 135 Macquarie St., Sydney, N.S.W.
Honorary Secretaries, State Branches:
New South Wales, Dr. E. W. Frecker, 135 Macquarie St., Sydney.
Victoria, Dr. T. L. Tyrer, 3 Lockerbie Court, East St. Kilda.
Queensland, Dr. J. Adam, 131 Wickham Terrace, Brisbane.
South Australia, Dr. B. C. Smeaton, 178 North Terrace, Adelaide.
Western Australia, Dr. A. M. Nelson, 179-B St. Georges Terrace, Perth.
New Zealand, Dr. E. G. Lynch, 12 Bolton St., Wellington.

South America

Sociedad Argentina de Radiologia
Secretary, Dr. Guido Gotta, Buenos Aires, Argentina. Meetings are held monthly.

Sociedade Brasileira de Radiologia Medica
Secretary, Dr. Nicola Caminha, Av. Mem de Sa, Rio de Janeiro, Brazil. Meets monthly, except during January, February and March.

Sociedade Brasileira de Radioterapia
Secretary, Dr. Andrelino Amaral, Av. Brigadeiro Luiz Antonio, 644, São Paulo, Brazil. Meets monthly on second Tuesday at 9 p.m. in São Paulo at Av. Brigadeiro Luiz Antonio, 644.

Sociedad Peruana de Radiologia
Secretary, Dr. Julio Bedoya Paredes, Apartado, 2306, Lima, Peru. Meets monthly except during January, February and March, at Asociación Médica Peruana "Daniel A Carrión," Villalta, 218, Lima.

Sociedad de Radiologica, Cancerologia y Fisica Medica del Uruguay
Secretary, Dr. Arias Bellini.

Continental Europe

Société Belge de Radiologie
General Secretary, Dr. S. Masy, 111 Avenue des Alliés, Louvain, Belgium. Meets monthly, second Sunday at Maison des Médecins, Brussels.

Ceskoslovenská společnost pro röntgenologii a radiologii v Praze
Secretary, Dr. Roman Bláha, Praha XII, stát. nemocnice, Czechoslovakia. Meets monthly except during July, August, and September. Annual general meeting.

Polish Society of Radiology
Secretary, Dr. L. Zgliczynski, 59 Nowogrodzka St., Warsaw, Poland. Next meeting May 13 and 14, 1948.

Gdansk Section, Polish Society of Radiology
Secretary, Dr. A. Smigielska, Akademia Lekarska, Gdansk. Meets monthly last Sunday at 10.30, X-Ray Dept., Akademia Gdansk.

Warsaw Section, Polish Society of Radiology
Secretary, Dr. L. Zgliczynski, 59 Nowogrodzka St., Warsaw, Poland. Meets monthly.

Societatea Romana de Radiologie si Electrologie
Secretary, Dr. Oscar Meller, Str. Banual Mărăcine, 30, S. I., Bucuresti, Roumania. Meets second Monday in every month with the exception of July and August.

All-Russian Roentgen Ray Association, Leningrad.
USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.
Secretaries, Drs. S. A. Reinberg and S. G. Simonson. Meets annually.

Leningrad Roentgen Ray Society
Secretaries, Drs. S. G. Simonson and G. A. Gusterin. Meets monthly, first Monday at 8 o'clock, State Institute of Roentgenology and Radiology, Leningrad.

Moscow Roentgen Ray Society
Secretaries, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky. Meets monthly, first Monday, 8 p.m.

Scandinavian Roentgen Societies
The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association.

Sociedad Espanola de Radiologia y Electrologia
Secretary, Dr. J. Martin-Crespo, Fuencarral, 7. Madrid, Spain. Meets monthly in Madrid.

Schweizerische Röntgen-Gesellschaft (Société Suisse de Radiologie)
President, Dr. H. E. Walther, Gloriastr. 14, Zürich, Switzerland.

ROCKY MOUNTAIN RADIOLOGICAL SOCIETY

The annual meeting of the Rocky Mountain Radiological Society, held in Salt Lake City, Utah, on August 12, 13 and 14, 1948, was a success both from its scientific and social aspects. The following were guest speakers at the meeting: Dr. L. H. Garland, Dr. John Caffey, Dr. Ross Golden, Dr. Juan A. del Regato, Dr. John D. Camp, and Dr. Wendell G. Scott.

The following officers were elected for the coming year: *President*, Dr. Howard B. Hunt, Omaha, Nebraska; *President-Elect*, Dr. K. D. A. Allen, Denver, Colorado; *First Vice-President*, Dr. M. Lowry Allen, Salt Lake City, Utah; *Second Vice-President*, Dr. Thomas B. Bond, Fort Worth, Texas; *Secretary-Treasurer*, Dr. M. D. Frazer, Lincoln, Nebraska.

SOCIEDAD DE RADIOLOGICA, CANCEROLOGIA Y FISICA MEDICA DEL URUGUAY

An announcement has recently been received from the President, Dr. Felix Leborgne, of the reorganization of the Sociedad de Radiologica, Cancerologia y Fisica Medica del Uruguay. The officers of the society are: *President*, Dr. Felix Leborgne; *Vice-President*, Dr. Alfonso Frangella; *Secretary-General*, Dr. Hector Bazzano; *Secretary*, Dr. Arias Bellini; *Treasurer*, Dr. Luis Vasque Piera; *Chancellors*, Dr. Mario Cassinoni and Dr. Augustin Gorlero Armas.

THE CATLIN MARK

TO THE EDITOR:

I have recently had called to my attention an article in the quarterly review of American archaeology, *American Antiquity*, April, 1945, Volume 10, No. 4. The title of this article is "Trepanation and the Catlin Mark," and is by William H. Goldsmith.

Goldsmith would lead one to believe that the Catlin mark, as well as prehistoric trepanation, is a commonplace occurrence. However, in the literature, as far as I can find, there are only the writings of Goldsmith, and of Pepper and Pendergrass, the latter in the AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY, 1936, Volume 35, pages 1–8, and 1939, Volume 41, pages 343–346. The fact is that the Catlin mark is quite uncommon and Pepper and Pendergrass speak of it as "an erratic hereditary anomaly of ossification" and the "formation of persistent enlarged parietal foramina." With these three exceptions, this is all that I can find in the literature.

My object in writing is that a brief note appear in the AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY calling attention to the fact that it has not been recognized in the roentgenograms of the skull of over 15,000 individuals, nor has it been observed in the physical and roentgen examination of the skulls of 1,500 skeletons in the Department of Anatomy of the Washington University School of Medicine, nor was an example of it found in 200 skulls of Mound Dwellers of Missouri, Illinois, and Arkansas. Among the latter, likewise, there was no example of a trephine opening. Trephine openings have been seen in the various museums, but they are not common in any of the museums of the United States.

SHERWOOD MOORE, M.D.

AVAILABILITY OF RADIOISOTOPES WITH INCREASED ACTIVITIES

The Isotopes Division is pleased to announce that it is now possible for Oak Ridge National Laboratory to distribute irradiated units of isotopes containing larger quantities of activities, and in many cases with higher specific activity, than those listed in Radioisotopes Catalog No. 2. Previously it was necessary to limit the quantity of activity present in an irradiated unit due to available facilities for protection of personnel removing samples from the pile. Recently these facilities have improved to such an extent that this factor is no longer a limiting one.

Limitations placed on the quantity of activity which may be shipped by public carrier still must be met. In some instances, a moderate increase in total activity may be shipped satisfactorily through increasing the weight of the

shipping container. However, if abnormally large quantities of activity are requested, it generally will be necessary for the applicant to furnish a special truck or plane for transportation. The Isotopes Division will be glad to cooperate in discussing the preparation of samples with high activities and arrangements for their transportation.

Since additional time and effort is required to prepare and handle these more active samples, the allocation of these materials will be made on the basis of service irradiations, discussed on page 28 of the catalog. Therefore, samples larger than those listed for the routine units may be procured at a cost of $22 for one week irradiation, or fraction thereof, or $43 per month.

Isotopes Division Circular E-26
Oak Ridge Operations
Oak Ridge, Tennessee

ATOMIC ENERGY COMMISSION POLICY ON PRODUCTION AND DISTRIBUTION OF ISOTOPE-LABELED COMPOUNDS

Commercial firms will be encouraged to manufacture and distribute for sale tagged compounds, the radioactive materials being obtained from the Atomic Energy Commission. This is in line with the Commission's announced policy of encouraging private industry to develop the use of radioactive materials wherever industrial participation proves feasible. Certain selected compounds for which adequate commercial production does not exist, will be produced in the contractor-operated laboratories of the Commission for general distribution by the Commission. However, the Commission hopes that private firms will enter the field to such an extent that it will be able in time to withdraw from the manufacture of such compounds for general distribution.

The price to be charged for isotope-labeled compounds produced by commercial firms will be established by the firm manufacturing the material in accordance with normal industrial practices.

Inventions or discoveries made by persons using radioisotopes or using or manufacturing isotope-labeled compounds will be subject to patenting by the inventor in accordance with normal industrial practices. The Commission does not contemplate the reservation of patent rights to inventions and discoveries made by distributees who receive radioactive materials pursuant to the Commission's regular program of radioisotope distribution.

The users of radioactive isotopes or isotope-labeled compounds will be required to meet the safety and health standards that are established from time to time by the Commission. They also will be required to publish or report the significant results of investigations using radioactive materials but these reporting requirements will be applied so as not to interfere with an inventor's opportunity to obtain patent protection for his inventions and discoveries.

At present radioisotopes are sold by the Isotopes Division at a price set to cover the costs of final fabrication. This price does not cover, for example, the cost of amortizing the investment in laboratory equipment and nuclear reactors, which are used for research purposes other than radioisotope production. Consequently, the present pricing policy results in a subsidy of research in which radioisotopes are used. If and when radioisotopes are used on a large commercial scale, it may be necessary to re-examine the pricing policy.

Although the pricing formula for distributing compounds produced by the Atomic Energy Commission will attempt to include all factors directly chargeable to the production of such compounds, the resulting price may not necessarily reflect all the costs which commercial organizations must include when determining the price of their compounds.

Isotopes Division Circular E-23
Oak Ridge Operations
Oak Ridge, Tennessee

BOOK REVIEWS

Books sent for review are acknowledged under: Books Received. This must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interest of our readers as space permits.

CANCER: DIAGNOSIS, TREATMENT, AND PROGNOSIS. By Lauren V. Ackerman, M.D., Pathologist to the Ellis Fischel State Cancer Hospital; Assistant Professor of Pathology, Washington University School of Medicine, St. Louis, and Juan A. del Regato, M.D., Radiotherapist to the Ellis Fischel State Cancer Hospital; Formerly Assistant to the Radium Institute of the University of Paris. Cloth. Price, $20.00. Pp. 1115, with 745 text illustrations and 42 color reproductions. St. Louis: C. V. Mosby Company, 1947.

Introductory chapters cover the Pathology of Cancer, Surgery of Cancer, Radiotherapy of Cancer, and a brief review of the Present Status of Cancer Research by Michael B. Shimkin of the National Cancer Institute.

The remainder of the book deals with cancer according to systems under the following headings: anatomy, incidence and etiology, pathology, clinical evolution, diagnosis, treatment and prognosis. The authors are to be commended for laying special emphasis on the clinical aspects of the various types of malignant disease and limiting the space devoted to histological pathology. All of the illustrations are of good quality, but the drawings made by Virginia Svarz Ackerman are unusually well done, particularly those which show the lymphatic drainage and paths of metastasis for each anatomical site of cancer origin. The clinical course of each type of malignant disease is described in some detail and, when possible, complicated data are placed in tables which serve to clarify the material appreciably.

To the radiation therapist, the book is disappointing. Although one of the authors is an authority on this type of therapy, no detailed techniques are set down and, for the most part, the subject is covered in a very general manner. It is also to be regretted that the authors express a prejudice against radium therapy apparently based on a lack of experience with this method. The following quotations will find little favor with competent radium therapists: "An accurate dosimetry is not possible with the use of radium," "Interstitial curietherapy is an expeditious method of treatment which is only justified in small lesions," "Interstitial application of radium element needles or radon seeds has been almost universally abandoned as a method of treatment of primary carcinomas of the lower lip," "Carcinoma of the tongue is one of the few remaining, if not the last, lesion for which this form of treatment is indicated." Having shown such a lack of confidence in the efficiency of radium, the authors express a surprising faith in roentgen therapy as evidenced by the following statement: "External roentgentherapy is capable of sterilizing metastatic carcinoma [in lymph nodes] from a primary lesion of the lower lip."

In spite of these defects, the general description of the appearance and behavior of the various types of cancer are so well done that every radiologist interested in therapy will find this book a very useful storehouse of information made readily available in a single volume of moderate size.

CHARLES L. MARTIN, M.D.

HODGKIN'S DISEASE AND ALLIED DISORDERS. By Henry Jackson, Jr., A.B., M.D., Assistant Professor of Medicine, Harvard Medical School; Associate Physician, Thorndike Memorial Laboratory, Boston City Hospital, and Frederic Parker, Jr., A.B., M.D., Associate Professor of Pathology, Harvard Medical School; Pathologist-in-Chief, Boston City Hospital. Cloth. Price, $6.50. Pp. 177, with 15 plates. New York: Oxford University Press, 1947.

In seven chapters, this important contribution to the subject of lymphoblastoma and lymphomatoid conditions deals at some length with Hodgkin's disease, reticulum cell sarcoma, lymphocytoma and lymphoblastoma, lymphosarcoma, giant follicle lymphoma, plasmocytoma, and endothelioma. The book is well printed and well bound in dark red buckram, and the quality of most of the illustrations is excellent.

Essentially this book, which does not deal exhaustively with the subject as far as a review and analysis of earlier writings are concerned, is an attempt of the authors to set forth their

personal views in relation to the clinical and pathologic phases of the problem. Perhaps the main feature of this work, and one which will attract most attention, is a new classification according to which Jackson and Parker claim to recognize three distinct forms of Hodgkin's disease: paragranuloma, Hodgkin's granuloma, and Hodgkin's sarcoma. This distinction, of course, is based purely on pathologic grounds (microscopic observations) and, for this reason, it probably must be attributed or credited to Parker. Without any doubt, this will stir up quite a controversy, because a great many pathologists will be unable to accept Parker's views in this respect. But sometimes controversy is valuable because it tends to stir sluggish minds to greater activity and to closer observation; and this might well result in the accumulation of greater knowledge.

Readers who have had substantial experience with this group of diseases will immediately question whether Jackson and Parker's "paragranuloma" deserves to be regarded as an independent entity. In relation to the symptoms and course of Hodgkin's disease, these readers will say, quite justly, that the reason for the absence of any symptoms in the condition which Jackson and Parker call "paragranuloma" is that the affected lymph nodes have not yet enlarged sufficiently to cause symptoms; in other words, that the morbid process is in an early stage when it would not be likely to produce symptoms. Against this, some would advance the objection that the long duration of paragranuloma in the small number of cases cited as examples would be against these being cases of true Hodgkin's disease. This, of course, is a misconception based on earlier writings which, in turn, were based on cases in which the malignant lymphoid process had reached an advanced stage. Those who have seen a large number of authentic cases know full well that, in a certain percentage, the patients can survive many years.

The statistics given by Jackson and Parker have not as much value as they might have, and this is also true of most of the statistics which have been published until now. Pathologists and many other physicians have a tendency to believe that necropsy findings must necessarily be accurate; but conditions which are found after death, while they are accurate as far as they go, may not represent a state of the lymphatic system and of other organs which may have been present some time before and which, during the terminal period of the patient's life, may have diminished or disappeared. As far as the lymphatic system is concerned, this is much more common and more important than is generally realized.

Another flaw—if flaw it can be called—relates to the case histories cited as examples of one phase or another. Jackson and Parker appear to have accepted at face value the histories which had been written by the attending physicians. But on reading these, anyone who has had an extensive experience of cases of this kind would know that, in all probablity, many of the patients had had, for many months or many years, other symptoms which had been disregarded or the cause of which had not been recognized.

The authors also seem to have accepted without question the statements of patients that enlarged lymph nodes in the neck had been the first manifestation of the disease, and from this they have assumed that Hodgkin's disease nearly always begins in the cervical nodes. This is an ingenuous and uncritical attitude which is all too common, but it does not happen to be true. Because the neck is such a prominent and accessible part of the body, because while shaving men have an exceptional opportunity to see the neck, and because women are greatly concerned with the appearance of their necks, it is only natural that any blemish or lump in this region should attract attention. But when some of the cervical nodes become abnormally large, a critical analysis of the circumstances will show that the cervical nodes are affected secondarily as often as they are affected primarily.

Compared with the other chapters, the chapter dealing with lymphosarcoma is quite brief. Apparently Jackson and Parker restrict the diagnosis of lymphosarcoma much more than do the majority of pathologists. How these will react to this exclusive attitude remains to be seen. Unless all signs fail, coming meetings of pathologists should be interesting.

Nevertheless, this book is a valuable contribution and deserves a careful study.

A. U. Desjardins, M.D.

Practical X-Ray Treatment. By Arthur W. Erskine, M.D. Third edition, revised and enlarged. Fabrikoid. Price, $4.50. Pp. 155, with 22 illustrations. Saint Paul and Minneapolis: Bruce Publishing Company, 1947.

This is a small volume closely packed with well chosen information and, as the author

states, it is not intended as a textbook for those well informed in this field. The fundamentals of equipment are well brought out, an excellent description is given of scattered radiation, and sufficient clinical information is included to give the novice a good idea of the problems involved.

The chapter entitled "The Cancer Problem and the Radiologist," could profitably be read not only by every radiologist, but by every practicing physician.

If there is any criticism directed against this book, it is simply that the author has made the subject seem so easy that those who are not qualified to do roentgen therapy may receive from it a false sense of security.

This should be a highly satisfactory compend for undergraduate medical students who wish to purchase a book on each subject while they are still in college, with the idea of building up a library for future study.

Robert B. Taft, M.D.

BOOKS RECEIVED

Hodgkin's Disease and Allied Disorders. By Henry Jackson, Jr., A.B., M.D., Assistant Professor of Medicine, Harvard Medical School; Associate Physician, Thorndike Memorial Laboratory, Boston City Hospital, and Frederic Parker, Jr., A.B., M.D., Associate Professor of Pathology, Harvard Medical School; Pathologist-in-Chief, Boston City Hospital. Cloth. Price, $6.50. Pp. 177, with 15 plates. New York: Oxford University Press, 1947.

X-Rays and Radium in the Treatment of Diseases of the Skin. By George M. MacKee, M.D., Professor of Clinical Dermatology and Director of Department of Dermatology (Skin and Cancer Unit), New York Post-Graduate Medical School and Hospital, Columbia University, and Anthony C. Cipollaro, M.D., Assistant Professor of Dermatology and Assistant Director of Department of Dermatology (Skin and Cancer Unit), New York Post-Graduate Medical School and Hospital, Columbia University. Contributor: Hamilton Montgomery, M.D., Associate Professor of Dermatology, Mayo Foundation for Medical Education and Research, Graduate School, University of Minnesota, Rochester, Minn. Fourth edition, thoroughly revised. Cloth. Price, $10.00. Pp. 668, with 321 engravings and 4 colored plates. Philadelphia: Lea & Febiger, 1946.

Radium Dosage: The Manchester System. Edited by W. J. Meredith, M.Sc., F. Inst. P., Christie Hospital and Holt Radium Institute, Manchester. Cloth. Price, $4.50. Pp. 124, with 38 figures and 4 plates, and numerous tables. Baltimore: Williams and Wilkins Company, 1947.

Selected Papers from the Royal Cancer Hospital (Free) and the Chester Beatty Research Institute. Vol. IV. 1943–1944. Cardboard. Price, 16s. Pp. 379, with numerous illustrations. London: Royal Cancer Hospital (Free), 1947.

Textbook of Endocrinology. By Hans Selye, M.D., Ph.D. (Prague), D.Sc. (McGill), F.R.S. (Canada), Professor and Director of the Institut de Médecine et de Chirurgie expérimentales, Université de Montréal. With a Preface by Professor Bernardo A. Houssay, Prix Nobel, 1947, Buenos Aires, Argentina. Cloth. Price, $10.24. Pp. 914, with numerous illustrations. Montreal, Canada: Acta endocrinologia, Université de Montréal, 1947.

Endogeneous Endocrinotherapy Including the Causal Cure of Cancer. Compendium by Dr. Jules Samuels. Specialist for endogeneous endocrinotherapy, Amsterdam. Cloth. Pp. 539, with 30 illustrations. Amsterdam, Netherlands: Holdert & Co., 1947.

Concise Anatomy. By Linden F. Edwards, Ph.D., Professor of Anatomy, The Ohio State University, Columbus, Ohio. Cloth. Price, $5.50. Pp. 548, with 324 illustrations. Philadelphia: The Blakiston Company, 1947.

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ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

ROENTGEN DIAGNOSIS

HEAD

SIMMONS, D. R., and PEYTON, W. T. Premature closure of the cranial sutures. *J. Pediat.* Nov., 1947, *31*, 528–547.

Craniostenosis is a relatively rare anomaly characterized by premature closure of the cranial sutures. There are many variations dependent on which sutures show early closure. Surgical intervention in the condition has been frequently tried but would be more successful if indications were more carefully considered and suitable operations employed. It is important that bony regeneration across operative defects be prevented.

Virchow first described craniostenosis in 1851. Von Graefe, in 1866, was the first to recognize the importance of craniostenosis in visual impairment. Lannelongue, in 1890, was the first to attempt operative correction of craniostenosis by removing strips of bone along the prematurely fused sutures. Jacobi emphasized that the operation should not be employed in true microcephaly.

Normally a slight separation of the cranial sutures is present at birth but by the end of the sixth month firm fibrous union is present. The posterior fontanelle should be closed by the sixth week and the anterior fontanelle by the sixteenth month. The growth of the skull and the obliteration of the cranial sutures depends on brain growth. In microcephaly premature fusion of all the sutures and the fontanelles occurs; in hydrocephalus both are delayed.

If unilateral brain atrophy is present in infancy the same side of the skull will be smaller. After the age of three only slight increase in the intracranial capacity occurs and any increase in size of the skull must be due to increased thickness and growth of the sinuses and facial bones. It has been demonstrated experimentally that cranial bones grow in a lateral direction from the suture lines which explains why, following premature synostosis of a cranial suture, growth ceases perpendicular to that suture.

Much confusion in terminology exists in classification of premature closure of the intracranial sutures. The authors suggest the following simplified classification:

A. Complete, early, premature synostosis of the cranial sutures (oxycephaly, turricephaly, türmschädel).
 1. Oxycephaly without facial deformity.
 2. Craniofacial dysostosis of Crouzon.
 3. Acrocephalosyndactylism.
 4. Delayed oxycephaly (onset after birth).

B. Incomplete early synostosis of the cranial sutures.
 1. Scaphocephaly: premature closure of the sagittal suture.
 2. Brachycephaly: premature closure of the coronal suture, or of the coronal and lambdoidal sutures.
 3. Plagiocephaly: premature asymmetrical closure of the sutures.
 4. Mixture.

C. Late premature synostosis of the cranial sutures after the skull has reached or nearly reached adult size.

Various causes for craniostenosis have been proposed such as meningeal inflammation, heredity, rickets, lues, glandular disturbance, and birth trauma. However, the true cause remains unknown. Craniostenosis occurs five times as often in males as in females. If the suture occurs after the age of three no symptoms should result. The resultant shape of the head depends upon the sutures involved. Early closure of the sagittal suture results in dolicocephaly; premature closure of the coronal suture results in brachycephaly. Closure of all sutures results in turricephaly from upward expansion against the patent anterior fontanelle.

Early recognition is important if surgical correction is to be effective. Common associated findings include exophthalmos from shallow orbits, divergent strabismus, saddle-shaped nose, prognathism, high arched palate and dental defects as seen in Crouzon's type of dysostosis. Other associated deformities may include hypertelorism, syndactylism, optic atrophy, convulsive seizures and various degrees of mental deficiency.

Roentgenograms will demonstrate the obliterated sutures with increased density and

thickness of the adjacent bone. The abnormal shape of the skull is more apparent by roentgen examination than on physical examination, particularly in older children. Shallow orbits, steep orbital roofs, a deep middle fossa, a short narrow orbital fissure and small frontal sinuses are all usually present. The basilar angle is decreased in oxycephaly and increased in scaphocephaly.

The authors discuss in some detail the means of operative correction.

The prognosis for life is dependent on the severity of the disease. Most patients will exhibit some mental deficiency. Optic atrophy and blindness are common dangers.—*Rolfe M. Harvey, M.D.*

Watson, Charles W., Murphey, Francis, and Little, Samuel C. Schistosomiasis of the brain due to Schistosoma japonicum. *Arch. Neurol. & Psychiat.*, Feb., 1947, *57*, 199–210.

The deposition of ova in the central nervous system is a rare complication of the infection in man. The authors review the literature obtaining to this condition and report in detail their findings in a patient in whom ova of *Schistosoma japonicum* were found in the brain.

The date of the patient's exposure to infected water was definitely known. About ten days later, he developed the typical signs and symptoms of infestation by *Schistosoma japonicum*.

The first cerebral seizure developed approximately 156 days following the original exposure to the parasite. Headache, loss of consciousness, confusion, aphagia and jacksonian attacks characterized the cerebral seizures. A space-taking lesion was localized in the left parieto-temporal region. At operation, a tumor mass was found which was thought to be a glioma. As the lesion was extensive, a biopsy was removed and a subtemporal decompression performed.

Histopathologically, the mass proved to be due to a granuloma which contained the *Schistosoma japonicum*. Because of this, active specific chemotherapy was begun.

The seizures continued in spite of large amounts of fuadin. The patient was therefore operated upon a second time four months later when it was noted that the lesion had disappeared, leaving behind a large area of scar tissue. Whereas at the first operation, marked compression of the lateral ventricle due to the granuloma was noted, at the second operation, it was obvious that the formerly compressed lateral ventricle had become greatly dilated.

The patient's general condition improved following the second operation and the seizures were becoming less frequent and less severe when the patient was last seen.

Excellent photomicrographs of the patient's cerebral lesion and a reproduction of the ventriculogram enhance the value of this important contribution.—*Philip J. Hodes, M.D.*

Hodgson, H. K. Graham. Cholesteatomata of the temporal bone. *Brit. J. Radiol.*, May, 1947, *20*, 202–204.

The development of a cholesteatoma requires a low grade chronic infection in a diploetic or poorly pneumatized mastoid. When the infection is virulent it either spreads through the antrum to the mastoid cells in a cellular mastoid, or in an acellular mastoid it infiltrates the bone producing a diffuse bone infection. On the other hand, in the case of a less virulent infection the progress is much slower. The normal mucosa of the tympanum is destroyed and replaced by epidermal cells. By a continuous process of desquamation and replacement the mass of debris enlarges. Bone is destroyed not by inflammation but by pressure erosion. The smallest part of the space in which this mass is enlarging is the aditus ad antrum, and therefore bony changes are frequently seen here first. With further enlargement the mass may erode through its containing wall. Perforations through the tegmen enter the middle fossa; in other directions the fistulae develop between the labyrinth of the external auditory canal.

In the roentgenogram cholesteatomas appear as areas of rarefaction in usually dense bone, which are less transparent than air cells of corresponding size would be. Usually these are in the region of the antrum and the margins are usually smooth, but in the presence of a few scattered cells the outline may be quite irregular. In the posteroanterior oblique views the destruction should be sought near the apex of the external canal. In oblique lateral views it is seen in the area between the tegmen tympani and the upper part of the posterior wall of the external auditory canal.

Mastoid abscesses are also areas of destruction but are usually found in the peripheral zone of the mastoid, and they are more common in a cellular mastoid. Cholesteatoma oc-

curs almost invariably in an acellular or poorly pneumatized mastoid.—*E. F. Lang, M.D.*

WELIN, SÖLVE. The x-ray diagnosis of cholesteatoma in the temporal bone. *Brit. J. Radiol.*, May, 1947, *20*, 192–201.

A cholesteatoma is transparent to roentgen rays and can be demonstrated only when it has produced bone changes. Minor bone changes can be appreciated only by examination of standard, accurately made views of the mastoid with a detailed knowledge of the normal structure of the temporal bone. Both mastoids should be examined, and the films should include the following projections or modifications: frontooccipital (Towne) projection, oblique lateral (Law) projection, submentovertical projection, and a projection with the long axis of the petrous pyramid parallel to the film (as the Stenvers).

Although cholesteatomas are sometimes easily demonstrated in sclerotic or even diploic mastoids, the presence of considerable pneumatization complicates the picture. In these cases it is important to remember that a negative examination does not exclude the possibility of the existence of a cholesteatoma.

When the mass of epithelial cells develops in the external canal the otologist usually refers the patient for roentgen examination only if there is a question as to the extent of the lesion. In this situation the tumor might erode the posterior wall or floor of the external canal and be visible in a Law projection and in a submentovertical view.

A cholesteatoma in the attic may produce one of three types of destruction, depending on its position. On the lateral wall it produces characteristic spike-like or rounded defects in the lower margin of the attic. In the roof it produces destruction upward toward the middle fossa. In submentovertical projections this destruction is shown and frequently remnants of the ossicles may be seen. A large percentage of cholesteatomas erode posteriorly, enlarging the aditus ad antrum. In almost half of all cases of cholesteatoma this enlargement of the aditus can be demonstrated. It must be remembered that these changes show only the presence of the lesion, and not its extent, as it may go on into the antrum or forward into the tympanum without producing further destruction.

In involvement of the antrum, the cholesteatoma usually must become quite large to produce destruction. This type (if not shown by concomitant enlargement of the aditus) is demonstrated most easily in films in the Towne projection. If the antral cholesteatoma is situated in a well pneumatized mastoid it may not be demonstrable.

Small cholesteatomas may produce no changes, or at best, minimal changes in the aditus. Large ones may be confused at times with mastoid abscesses, although clinical differentiation is not so difficult.—*E. F. Lang, M.D.*

NECK AND CHEST

MASSOPUST, LEO C. Infrared photographic study of the superficial veins of the thorax in relation to breast tumors. *Surg., Gynec. & Obst.*, Jan., 1948, *86*, 54–58.

In this preliminary report on the use of infrared photography in the diagnosis of breast tumors a simple technique using a Wratten No. 87 filter, infrared film and flat incandescent illumination is briefly described.

Tumors alter the pattern of the superficial veins of the breast and in an encouraging number of cases the pathologic diagnosis confirms the photographic findings. In several malignant cases the photographs revealed unilateral wrinkling below the nipple and other slight distortions which were difficult or impossible to see with the naked eye.

Study of more cases by the method is indicated to evaluate its usefulness as an adjunct in the detection and classification of breast tumors.—*J. L. Boyer, M.D.*

ABRAMSON, W., and WARSHAWSKY H. Cancer of the breast in the male, secondary to estrogenic administration; report of a case, *J. Urol.*, Jan., 1948, *59*, 76–82.

Estrogenic therapy for prostatic carcinoma is an accepted procedure. The effect is apparently due to inhibition of the trophic functions of the anterior pituitary which causes decreased stimulation of adrenogenic glands. Cancer of the breast has been produced experimentally in male mice by estrogenic injections. Patients receiving estrogenic therapy frequently develop painful swollen breasts. Previous reports of the development of breast cancer in females receiving estrogenic therapy have been made but no previous reports in males.

The dosage of stilbestrol used in this type of therapy is discussed and the authors then report the case of a fifty-one year old colored male

who was admitted to the hospital for a painful back. Roentgen studies showed multiple metastatic lesions of the spine and femurs and pelvis from prostatic carcinoma.

The patient was given 1 mg. of stilbestrol daily for approximately eighteen months following refusal of orchidectomy. At the end of this period both breasts showed definite hypertrophy but no axillary adenopathy was noted. At this time a bilateral orchidectomy was performed. Following operation the patient was discharged with the advice to continue his stilbestrol therapy. Approximately six months later several hard nodules were palpated in both breasts. Death occurred three months later at which time an autopsy revealed bilateral extensive carcinoma of the breast with axillary metastases.

The authors do not advise discontinuance of estrogenic therapy in prostatic cancer but do recommend careful frequent examination of the breasts in cases undergoing such therapy and discontinuance of the therapy if nodules develop in the breasts.—*Rolfe M. Harvey, M.D.*

Sweet, R. H., Findlay, C. W., and Reyersbach, G. C. The diagnosis and treatment of tracheal and esophageal obstruction due to congenital vascular ring. *J. Pediat.*, Jan., 1947, *30*, 1–17.

Double aortic arch was considered a pathological curiosity prior to 1925. Medical treatment is not satisfactory. Patients die of suffocation or repeated pulmonary infarcts or are forced to live on soft or liquid diets. Surgical intervention was suggested by Sprague in 1933. The author discusses in detail 2 illustrative cases.

The first case was that of a $3\frac{1}{2}$ month old male infant who was admitted for a paroxysmal cough and wheezy breathing which had been present since ten days after birth. Recurrent attacks of cyanosis had also been noted. A chest roentgenogram showed increased hilar density and a diagnosis of virus pneumonia was made. The patient became cyanotic during a feeding spell and was transferred to the Massachusetts General Hospital.

Roentgenograms showed a posterior indentation of the barium-filled esophagus at the level of the aortic arch and an indentation of the right lateral border of the esophagus at a slightly more distal level. The impression was right-sided aortic arch and a vascular ring about the esophagus and trachea. At operation a double aortic arch was found and an anomalous left innominate artery which arose from the left aortic arch. A patent ductus arteriosus was also present connecting the left aortic arch to the pulmonary artery. The patent ductus and the left aortic arch were ligated and divided. This resulted in freeing the esophagus and trachea from their previous constriction.

Following operation dysphagia was no longer noted and breathing was normal except for slight cyanosis with crying spells. Postoperatively a bronchogram showed slight indentation of the right side of the trachea by the right aortic arch and sharp deviation of the trachea to the right just distal to this. The left main bronchus emerged from the trachea at an acute angle and was constricted in its midportion. The authors discuss the embryology of the great vessels of the heart showing why reported anomalies occur.

Case II was that of a nine month old male who had had a persistent loose cough since discharge from the maternity hospital. The cough gradually became worse and the patient began to vomit feedings. A roentgenogram of the chest showed a prominence of the upper mediastinal shadow on the right. A barium swallow at the age of two showed displacement of the superior mediastinum to the right and narrowing of the trachea, posteriorly, at the level of the aortic arch and on the right. A vascular ring encircling the trachea and esophagus was considered the probable diagnosis. At the age of four this diagnosis was confirmed by demonstration of anterior and posterior compression of the esophagus and anterior displacement of the trachea. At operation a double aortic arch was found and the right aortic arch was ligated and severed. This case was apparently a mirror image of the first and the embryological development is fully discussed and illustrated.

The differential diagnosis of respiratory stridor in infants is then discussed. Emphasis is placed on the diagnosis of double aortic arch as a possible cause, especially when aggravated by swallowing. A summary of the pertinent roentgen findings in double aortic arch includes the following: widening of the superior mediastinal shadow to the right on the posteroanterior film of the chest, absence of the aortic knob on the left, lateral indentation of the barium-filled esophagus, posterior indentation

of the esophagus, forward and lateral displacement of the trachea and esophagus, and narrowing of the trachea as demonstrated by bronchography.

The surgical approach is also discussed. Early operation is advisable once the diagnosis is established, although it is possible that symptoms may never develop.—*Rolfe M. Harvey, M.D.*

ROENTGEN AND RADIUM THERAPY

PFAHLER, GEORGE E., and KEEFER, G. P. Roentgen therapy in chronic mastitis. *Pennsylvania Med. J.*, Sept., 1947, *50*, 1347–1356.

Chronic mastitis has also been described as mazoplasia, chronic cystic mastitis, fibrocystic mastitis, adenofibrosis, and Schimmelbusch's disease. It is characterized by pain and tenderness, usually preceding the menstrual period, and by diffuse or localized nodularity of the breasts. Ewing believed that the disease begins as an inflammation or functional hypertrophy and often ends as a neoplasm. On the basis of a chronic inflammatory productive process, roentgen therapy is useful as such inflammatory processes in general have been found to yield to irradiation.

We nearly always find a nodular or local increased density over the painful area, and most often it involves the upper outer quadrant. Sometimes a localized nodule or more prominent irregular mass is found which suggests carcinoma. If there are associated smaller areas of induration, and if the opposite breast is involved, even to a much less extent, and if the symptoms are definitely associated with or precede the menstrual period, one is justified in treating it as a chronic mastitis, but probably not for more than a month or two unless there is some definite improvement. A discharge from the nipple is at times associated with chronic productive mastitis and may be the only symptom. If this is serous in character, it is not likely to indicate cancer. This discharge commonly is arrested by irradiation, but if it is bloody, one must be cautious as it may signify cancer.

The authors realize that clinical judgment or clinical diagnosis without biopsy or mastectomy cannot be absolutely reliable. Neither can a small amount of tissue removed in these cases for microscopic study or puncture biopsy be reliable, for it has been shown that carcinoma is more apt to be found in the small nonpalpable cysts than in the larger ones, also that removal of a large cyst for diagnosis may leave the small carcinomatous cyst in the breast. Where possible, cases should be seen jointly by radiologist and surgeon.

Of the 151 cases treated by one of the authors 30 had local excisions of the tumor tissue, and in these 30 cases which were considered doubtful only one showed cancer. Of these 151 cases, 111 showed complete recovery and an additional 35 cases have shown very marked improvement or practically recovery, leaving only 2.6 per cent of failures. From the fact that only one out of 151 patients with diseased breasts developed cancer of the breast, the authors conclude that the clinical diagnoses were extraordinarily accurate or the treatment prevented the development of carcinoma in some of the cases.

The treatment of this condition differs markedly from that for cancer in which case the technique is identical with that given for preoperative treatment. In chronic mastitis the authors aim to give as little treatment as is possible for satisfactory results. Therefore, they confine the treatment to the palpable disease or to the painful tender areas. They usually only need to give from four to six treatments. Usually the treatment is given through a 6 by 8 cm. field, and because the upper outer quadrant is most often involved, they begin in that area. The second treatment is given a week later from the opposite side of the breast. The third treatment is given two weeks later, and then four weeks apart for the fifth and sixth treatments. Each treatment represents a 50 per cent erythema dose, using high voltage rays.—*K. K. Latteier, M.D.*

BACLESSE F. Radiothérapie des cancers du larynx (endolarynx); résultats éloignés obtenus dans 341 cas irradiés à la Fondation Curie. (Radiation therapy of cancer of the larynx (endolarynx); end results obtained in 341 cases irradiated at the Curie Foundation.) *J. de radiol. et d'électrol.*, 1946, *27*, 63–64.

This statistical study, one of the most interesting published up to the present day, consists of 341 cases of cancer of the "endolarynx." This term is used to mean cancers of the larynx *excluding* those of the hypopharynx, the ary-epiglottic fold, and those of subhyoid involvement of the epiglottis. All reported were treated

between 1919 and 1940 and have a minimum follow-up period of five years. A large number of these cases were treated by Dr. Coutard (or under his direction) up to 1937. Histopathologically, the lesions were epitheliomas. Two sarcomas were excluded from this series. Among these 341 cancers were 16 females of which 6 remained cured. The total of complete cures for all cases irradiated during the twenty-one years was 17 per cent (59 cures in 341 cases). This figure includes all the cases treated by roentgen rays and radium and includes those receiving postoperative irradiation following hemilaryngectomy or complete laryngectomy. Two hundred ninety-nine cases treated by roentgen ray gave 58 cures. Forty-two cases treated by radium gave a single cure (one woman).

From the standpoint of extent of lesion and adenopathy the following number of cures was obtained:

Cancer without adenopathy and confined locally to the vestibule, vocal cords, or subglottic area: 40 per cent cure (20 cures in 51 cases). Extensive lesions without adenopathy: 18 per cent (35 cures in 189 cases). Extensive lesions with adenopathy: 4 per cent (2 cures in 49 cases). Lesion in subglottic region: (1 cure in 14 cases).

These statistics are established in a rigid manner since they include *all* cases treated and patients apparently cured, but dead of an intercurrent disease before five years, are counted as a failure.

The results obtained in the course of the last year of this study (1940) can better measure the progress realized than can the study of the entire series which is necessarily affected by technical and clinical errors in the earlier years. In 1940, in 33 treated laryngeal cancers 13, or 39 per cent, remain cured after five years. Cancers of the vestibule, all of which had rather extensive involvement, gave 14 per cent cure (2 cures in 14 cases). Cancers limited to the vocal cord were all cured: 100 per cent (5 cures in 5 cases). No cancer in the subglottic region was irradiated in 1940, this variety being reserved for surgery exclusively.

The author believes that the progress obtained in the results of radiation treatment of laryngeal cancer over the years 1919–1940 in his institution is due to: (1) utilization of small fields which are progressively reduced in size toward the end of the series of treatments, and (2) the increase in total duration of treatment. This fractionation (6–8–10–12 weeks) has been used regularly during the past six years.—*William M. Loehr, M.D.*

MISCELLANEOUS

LAMARQUE, P. Une visite aux laboratoires américans de radiologie à la fin de la guerre. (A visit to American laboratories of radiology at the close of the war.) *J. de radiol. et d'électrol.*, 1946, *27*, 40–46.

The author reports on a four months' visit to the United States and Canada between June and October, 1945. To the American radiologist, so accustomed to steady, uninterrupted, and unexcelled technological advancement, this article by Dr. Lamarque underlines the recent outstanding American achievements immediately apparent to a European visitor. It is good to see an appraisal of our advantages and our work through the eyes of a foreign colleague.

His comments cover: (1) Roentgenologic apparatus—our excellent rotating-anode tubes, control panels mounted on the wall (in contrast to cumbersome control stands taking up floor space in European departments), our more widespread use of stereoscopic films, the use of the phototimer and photofluorography, the better quality of film emulsions in U. S. films than in European films even before the war, the work and apparatus making cardioangiography possible, the supervoltage roentgen therapy equipment at Memorial Hospital (1,000–2,000 kv., peak), the van de Graaff type at Boston, the Kerst betatron and the great numbers of cyclotrons throughout the United States. The author says, "At the present time there is a cyclotron almost everywhere." (2) Radium therapy—radium therapy here differs little from that in France, the most striking items here being the radon gold seeds, the ingenious device of Failla's for preparing the gold seeds, and, of course, the very convenient dosage tables of Failla, Quimby and Marinelli. (3) Dosimeters—the general availability of Victoreen r-meters in nearly all departments and offices and the great number of full-time physicists attached to hospital departments as well as large numbers of radiation physicists available for calibrating roentgen therapy apparatus throughout this country. (4) Radiotherapy techniques—as everywhere throughout the world, techniques of radiation treatment vary from place to place and from school to school. The author felt that in the United

States there is, in general, less preoperative and postoperative irradiation for cancer of the breast than in his own country. He was also struck by the great variations in treatment techniques for cancer of the larynx, as to when surgery was resorted to, the variations in extent of surgical attack and lymph-node dissection. Details of three different major methods of irradiating cancer of the larynx in three large radiation centers in the United States are given, namely, those of Dr. Martin at Memorial Hospital, Dr. Lenz at Columbia Medical Center, and Dr. Cutler at Tumor Institute, Chicago. (5) Therapy of cancer of the uterine cervix—in the United States this type of cancer seemed to the author to be treated according to two general methods based upon two influences, the school of thought championed by the Radiumhemmet of Stockholm, and that of the Institute of Radium at Paris, the one using a massive dose of radium for a short time and the other a less massive dose over a more prolonged period. The author felt that in our country more therapists followed the Stockholm school. (6) Laboratories of pure research—the work of Marinelli at Memorial Hospital on radioactive iodine and of Quimby at Presbyterian Hospital with radioactive sodium in studying patients with vascular lesions by tracer technique is well summarized. The list ends with an emphasis on the importance of the work of Quimby. Failla, Marinelli and White on the establishment of the gamma-roentgen as a means of more correctly expressing the dose absorbed by the tissues. Much of the research being carried on at the Radiation Laboratory at Berkeley, California, was not accessible to the author as the Unted States was still practically at war (July to October, 1945).

Dr. Lamarque visited radiological departments in Philadelphia, New York City, Boston, Rochester (N. Y.), Cleveland, Detroit, Chicago, Minneapolis, The Mayo Clinic, San Francisco and Los Angeles and in each place found a cordial reception and felt that American physicians have an affection for his country which his countrymen should not underestimate.

Dr. Lamarque is the abstractor of the American radiological literature for the *J. de radiol. et d'électrol.*—*William M. Loehr, M.D.*

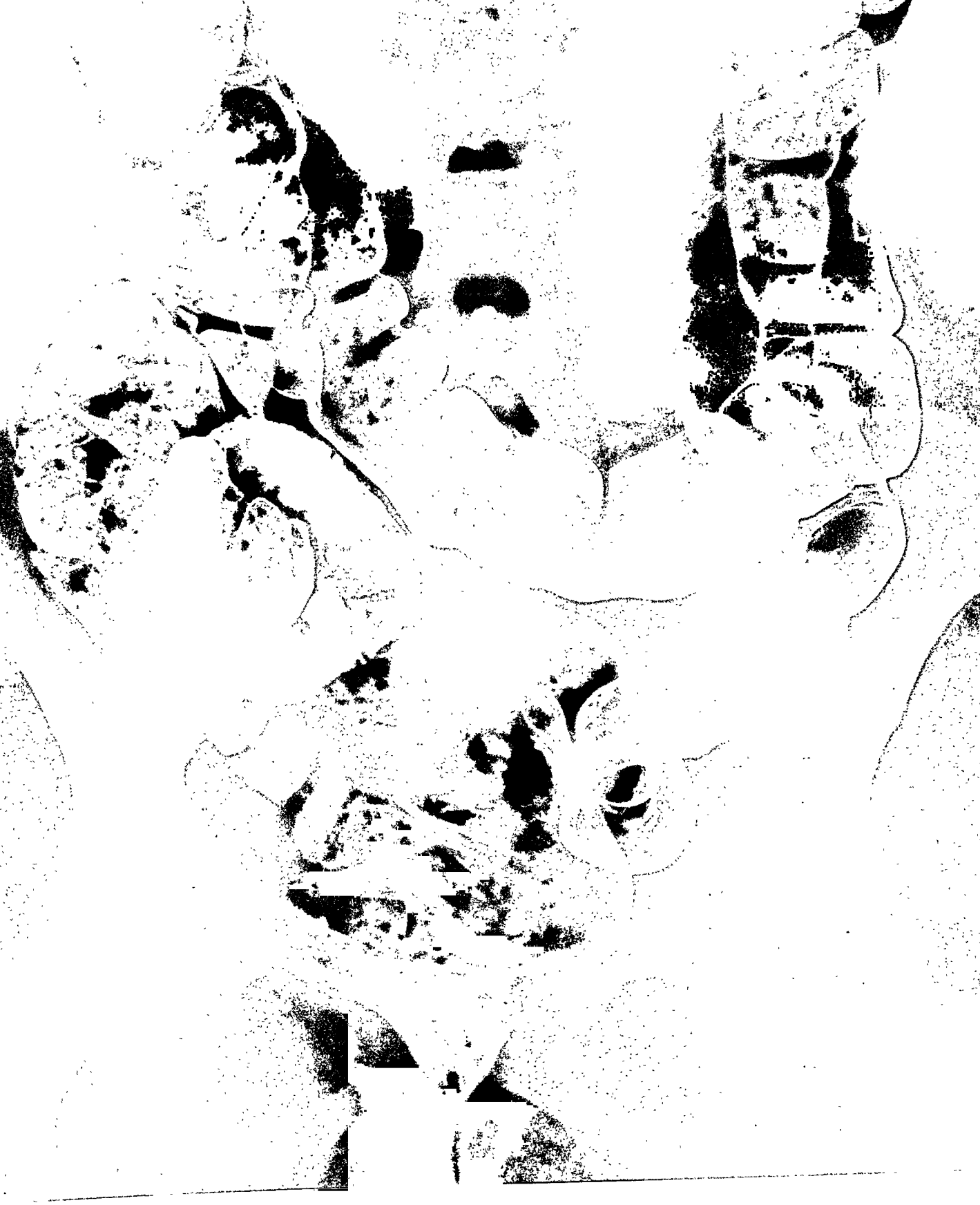
REIDY, JOHN A., LINGLEY, JAMES R., GALL, EDWARD A., and BARR, JOSEPH S. The effect of irradiation on epiphyseal growth. II. Experimental studies upon the dog. *J. Bone & Joint Surg.*, October, 1947, *29*, 853–873.

Studies previously completed on the young rat by the authors showed that it was possible to impede growth in the long bones by exposing the epiphyseal cartilages to roentgen irradiation. These investigations demonstrated clearly that, with dosages of between 665 r and 1,165 r the epiphyseal cartilage was affected profoundly. The adjacent tissues—such as synovial membrane, articular cartilage, cortical bone, bone marrow and skin—evinced morphological changes of minor import.

To verify the results of the rat experiments and to expand the scope of the animal investigations, it seemed advisable to do a similar study on dogs. These experiments were undertaken because of their possible therapeutic application to man.

Roentgen dosages of from 800 to 1,200 r were directed over selected joints of six-week-old dogs. The treated area included the joint, epiphysis and adjacent metaphysis. The epiphyseal cartilage was profoundly affected, and retardation of growth occurred. The articular cartilage of the treated joints showed frank microscopic evidence of degenerative changes, and was not as thick as in the controls. These changes were not sufficient to interfere with joint function during the period of the experiment, and were not apparent on gross examination. There was no evidence of significant abnormality in the adjacent cortical or cancellous bones, synovial membrane, joint capsule, skin or periarticular soft tissues. In 8 of 12 animals, mild bowing of the treated forelimb occurred. No such deformity occurred in the hind limbs. Although shortening of the treated bone occurred in each instance, there was stimulation of growth at the untreated epiphysis of the treated long bone. The cause of this stimulating effect was not apparent.

The authors conclude that the clinical use of roentgen irradiation of growing epiphyses to control longitudinal growth inequalities in children must be considered as experimental, and fraught with some potential dangers. Whether the danger is greater than is incurred in surgical procedures such as lengthening or shortening of the lower extremity and epiphyseodesis, must await further investigation.—*R. S. Bromer, M.D.*

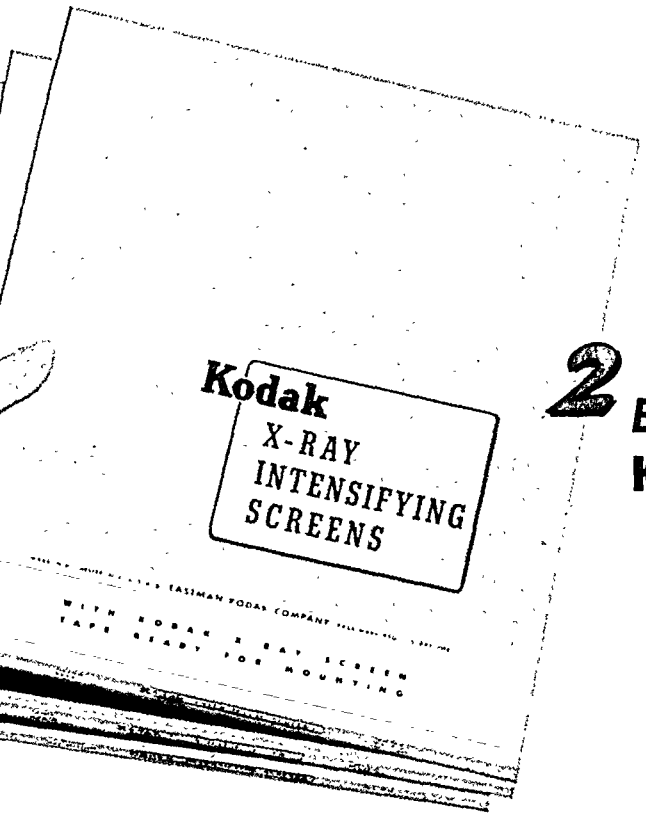


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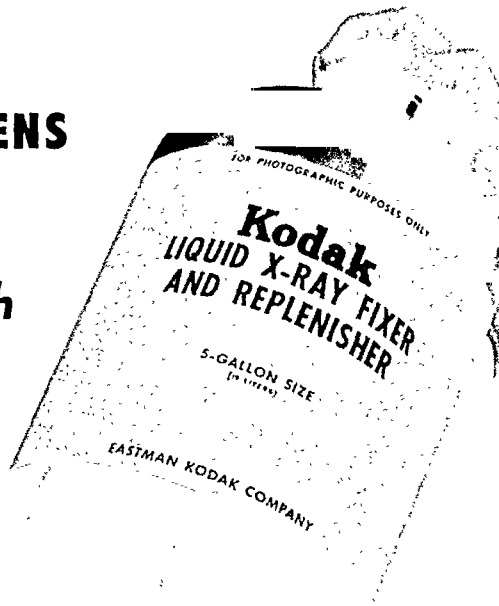


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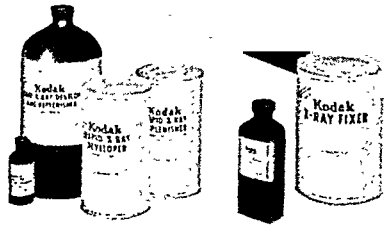
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A film to speed up mass survey work this Fall!

Fall x-ray check-ups in both schools and factories start this month.

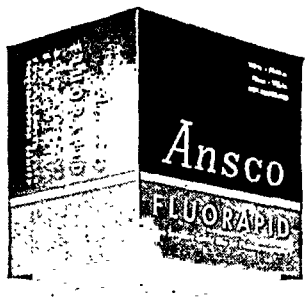
And it would seem wise to investigate anything that will speed up these check-ups and increase the value of your mass survey work.

Actual experiments have shown that the new Ansco 70mm Fluorapid film does speed up procedure considerably and permits significant savings in operating costs. It has been shown by actual test that the high sensitivity of Ansco 70mm Fluorapid film reduces exposure times by as much as 40%. Shorter exposures also prolong the useful life of the expensive tube.

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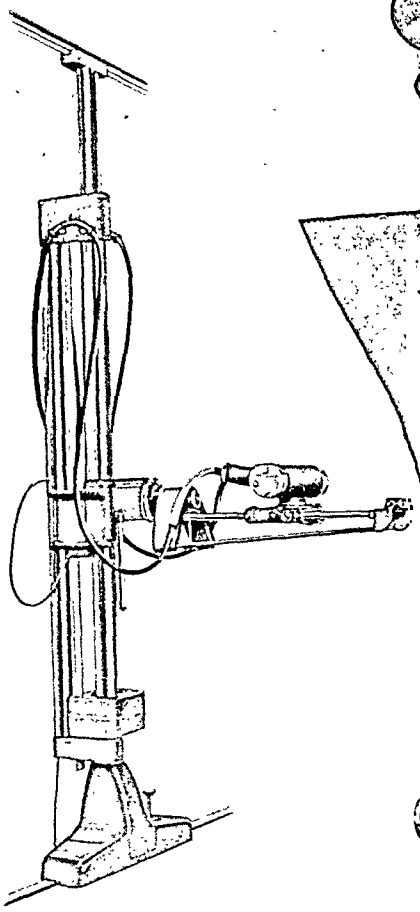


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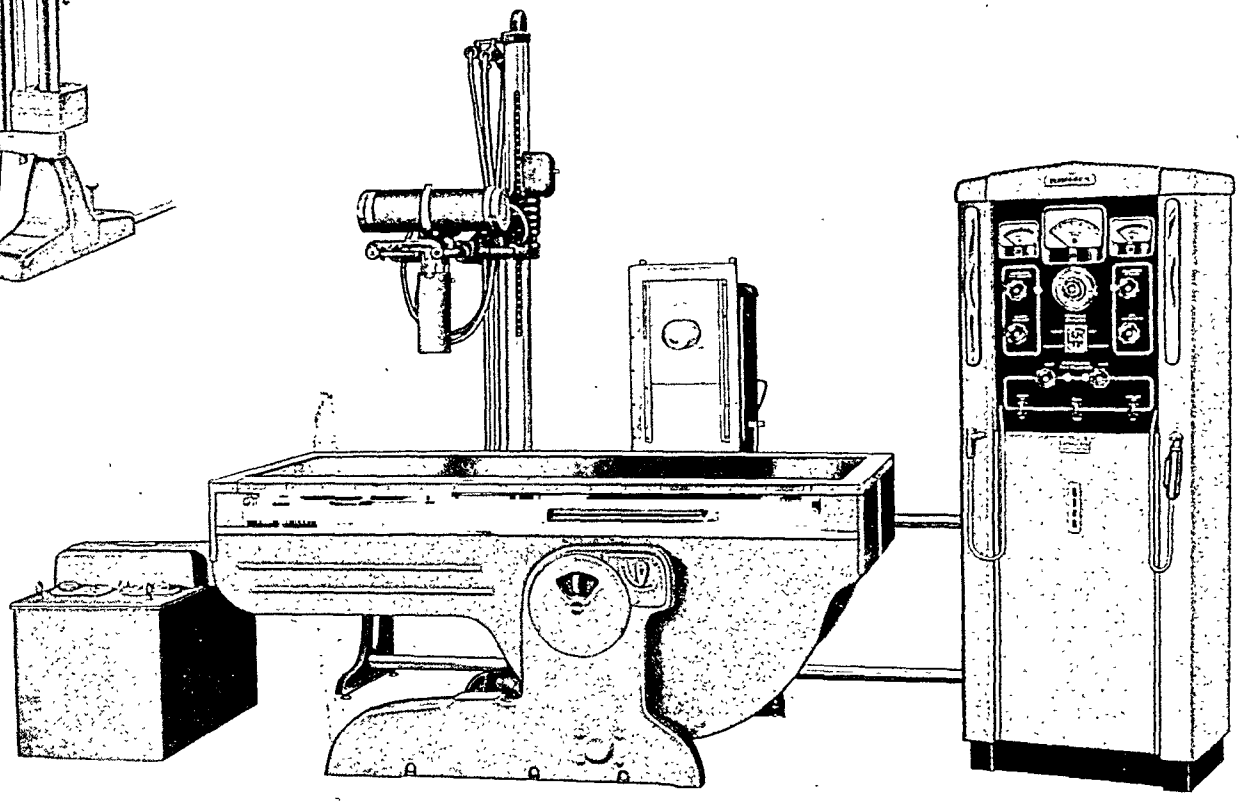
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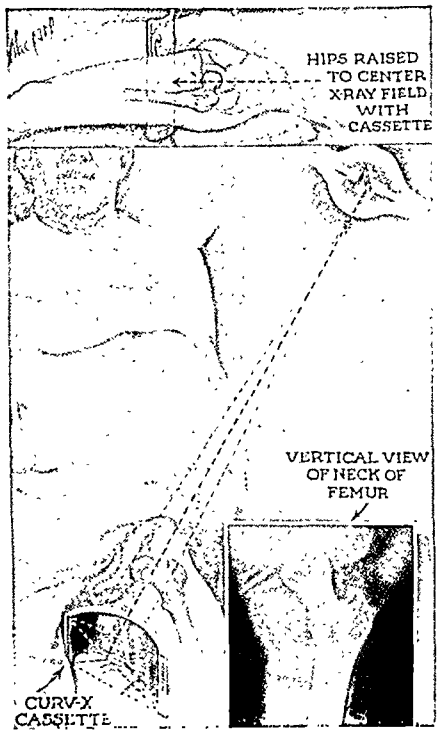
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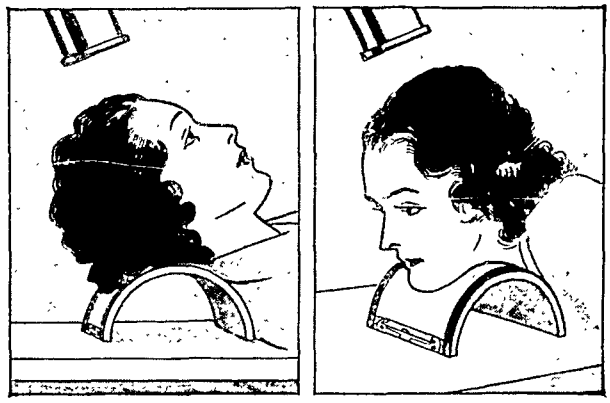
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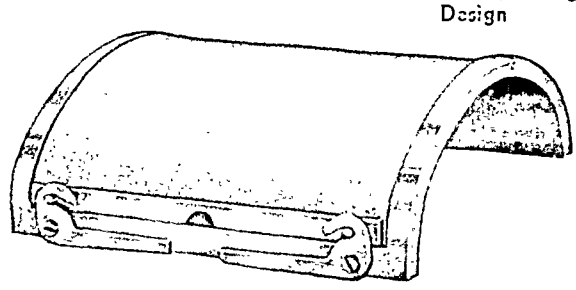


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Roentgen Diagnosis of Diseases of the Gastrointestinal Tract

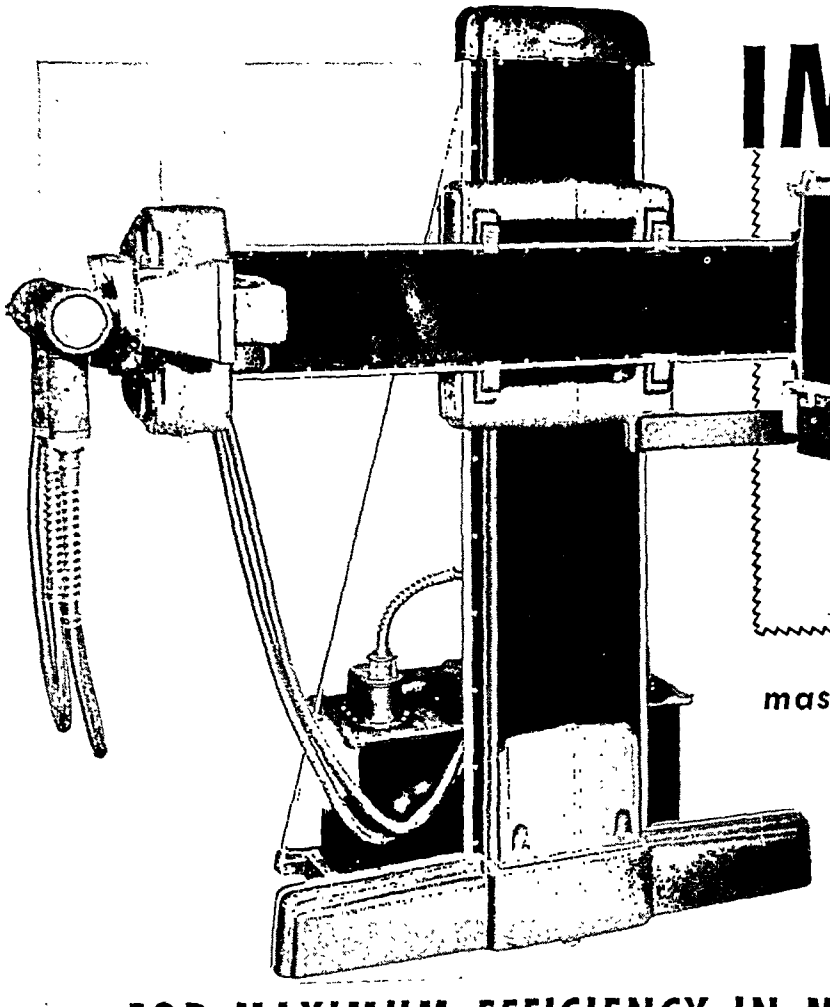
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Graduate School of Medicine
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293 pages 190 illustrations

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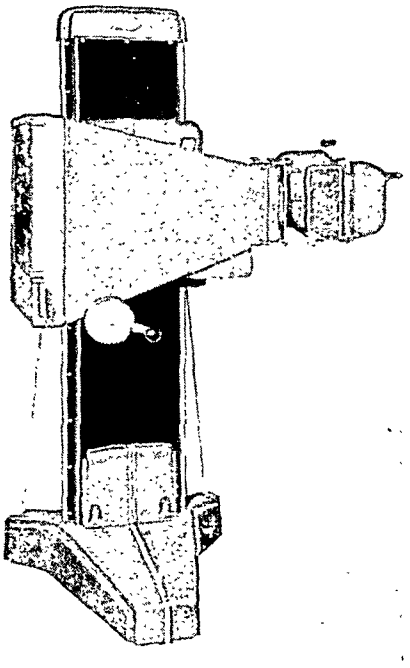
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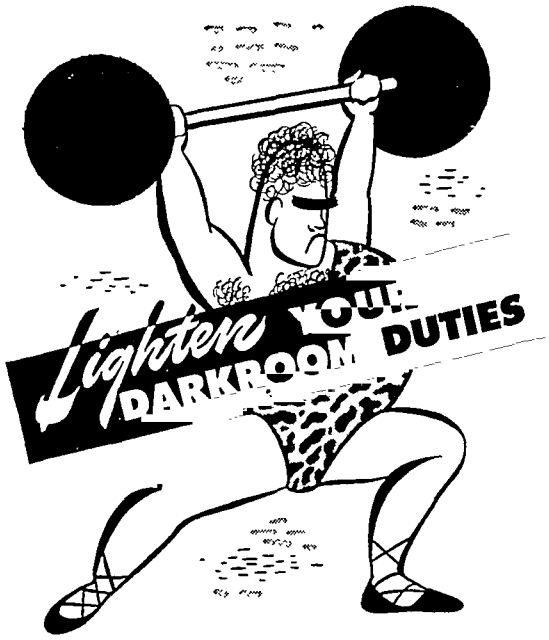
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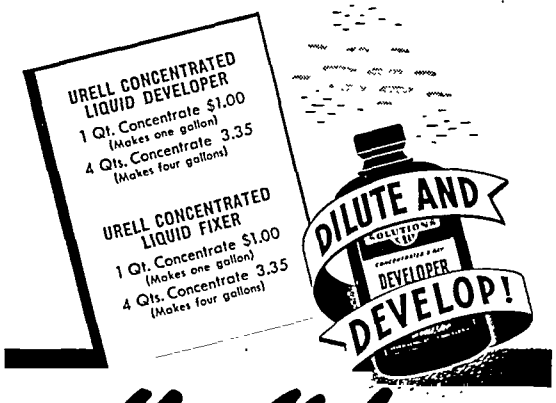
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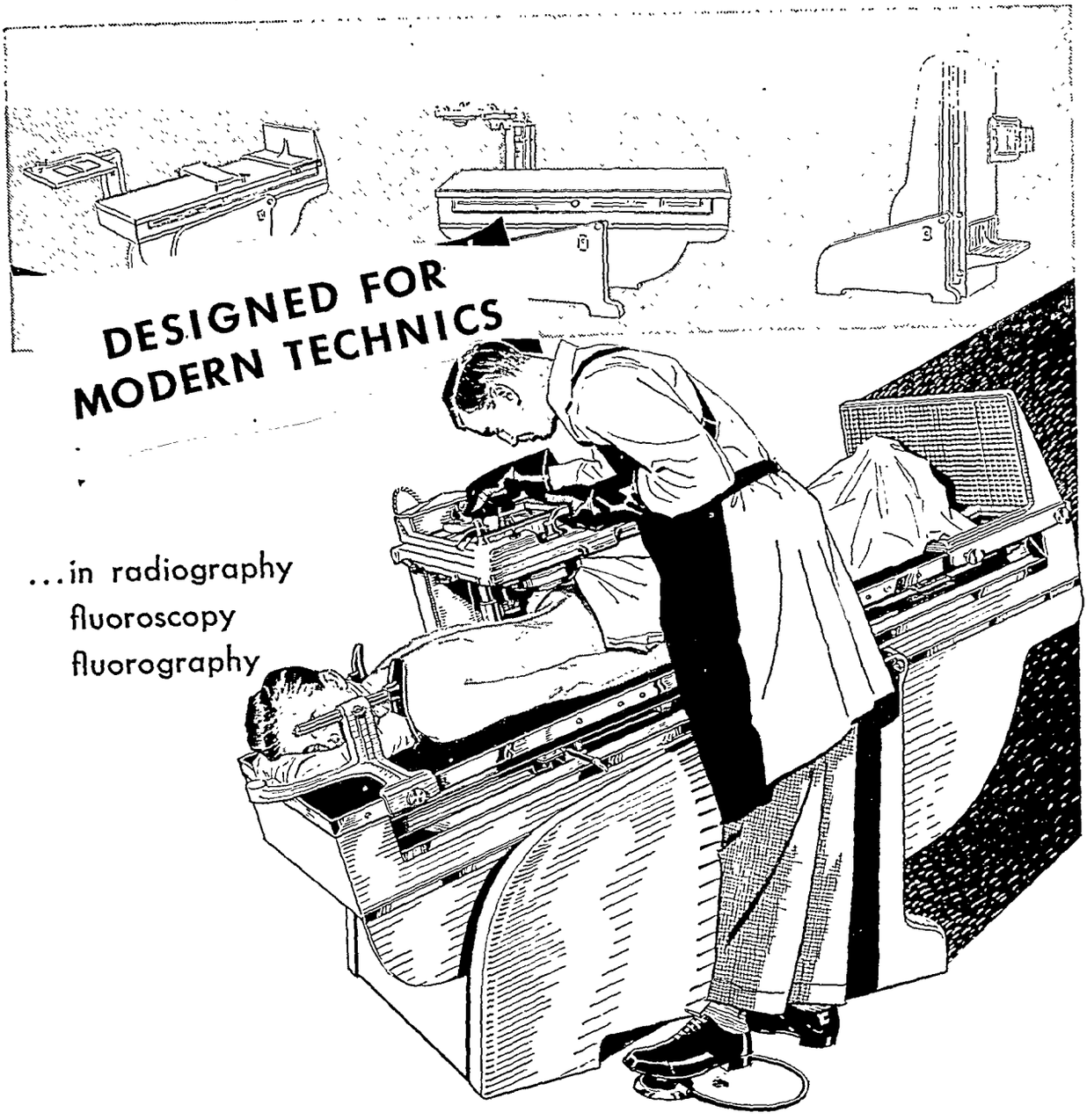
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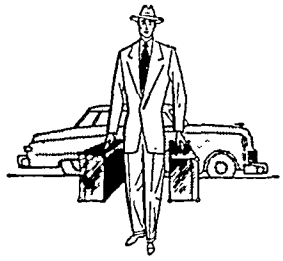
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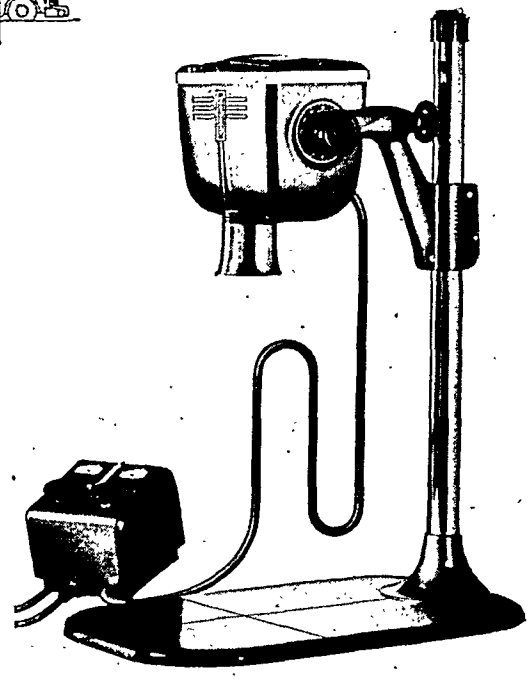
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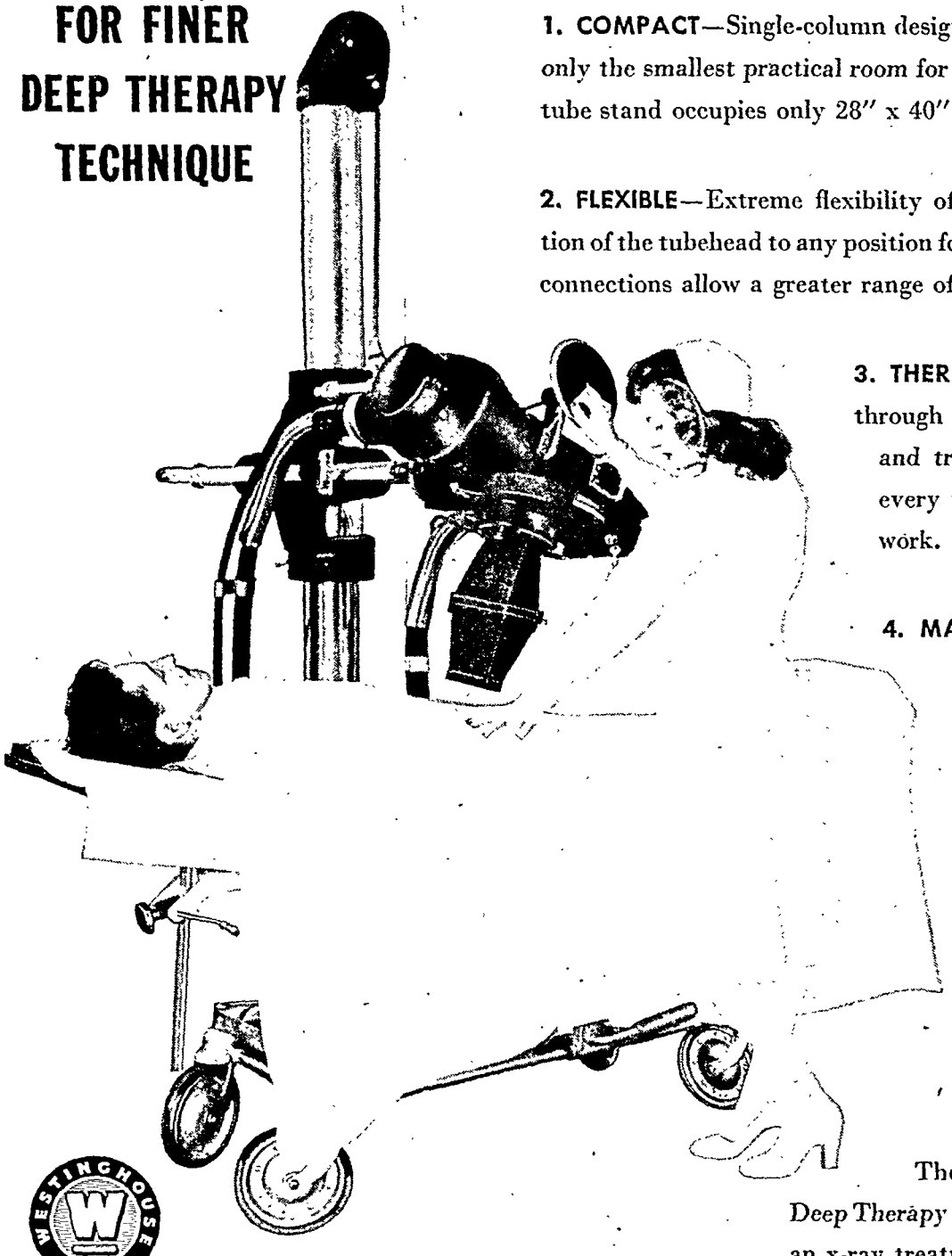
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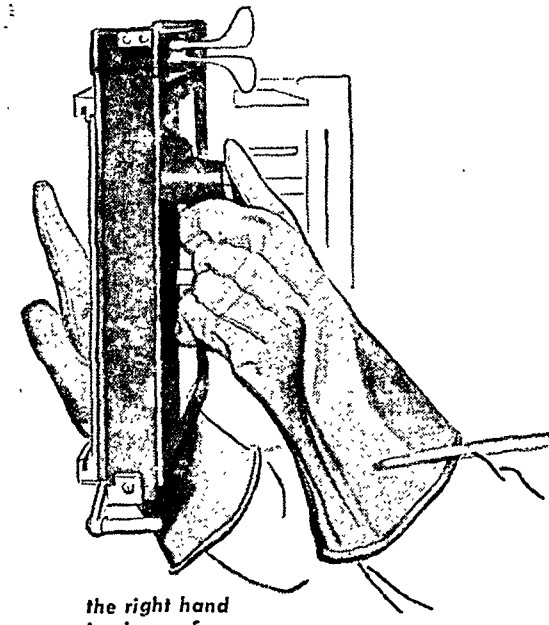
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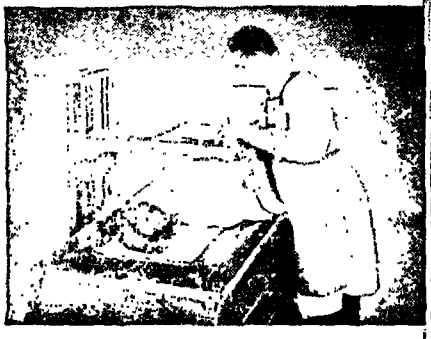
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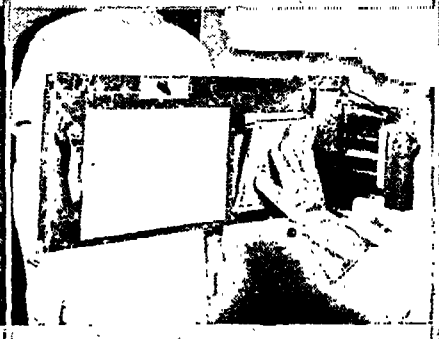
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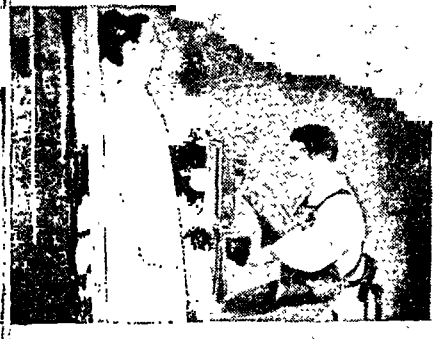
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VOLUME 60 OCTOBER, 1948 NUMBER 4

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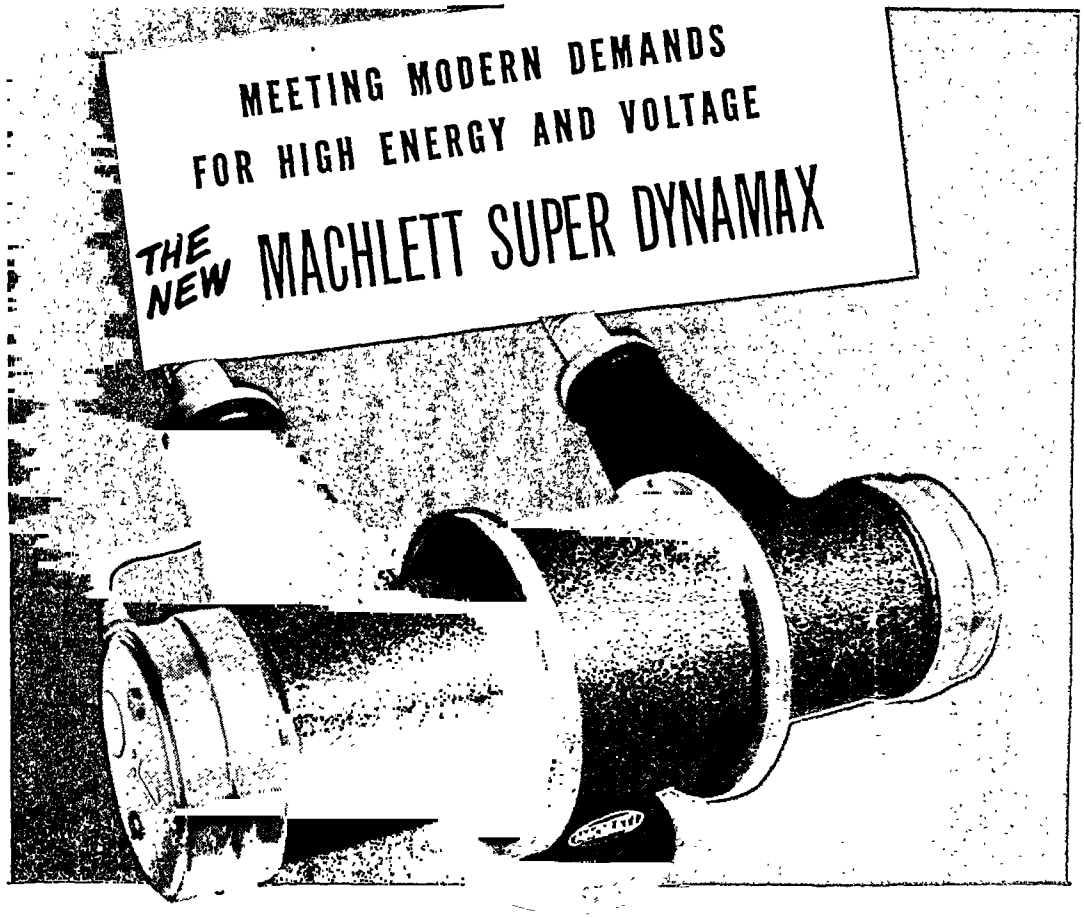
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• Recent developments in diagnostic techniques have resulted in a pronounced demand for x-ray tubes having energy ratings and heat dissipating capacities far beyond those offered by conventional stationary or rotating anode diagnostic tubes. These techniques include such new applications as high-speed photoroentgenography and cineradiography of heart action and joint movement. In order to obtain proper exposures and fine detail in rapid sequential order, fine focus and high energy loadings must be employed. These necessitated a further development of the rotating anode principle which Machlett pioneering did so much to bring to the point of practicality, reliability and economy.

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> *Typical Example.* With this remarkable new tube, it is possible to make 15 exposures per second, at 1/60th second each, 110 PKV, 400 ma., for a period of 10 seconds.

The new Super Dynamax is rayproof and shockproof and weighs only 45 pounds. It can be installed on tube carriages designed to take other modern lightweight rotating anode tubes, such as the famous Dynamax "25" and "26".

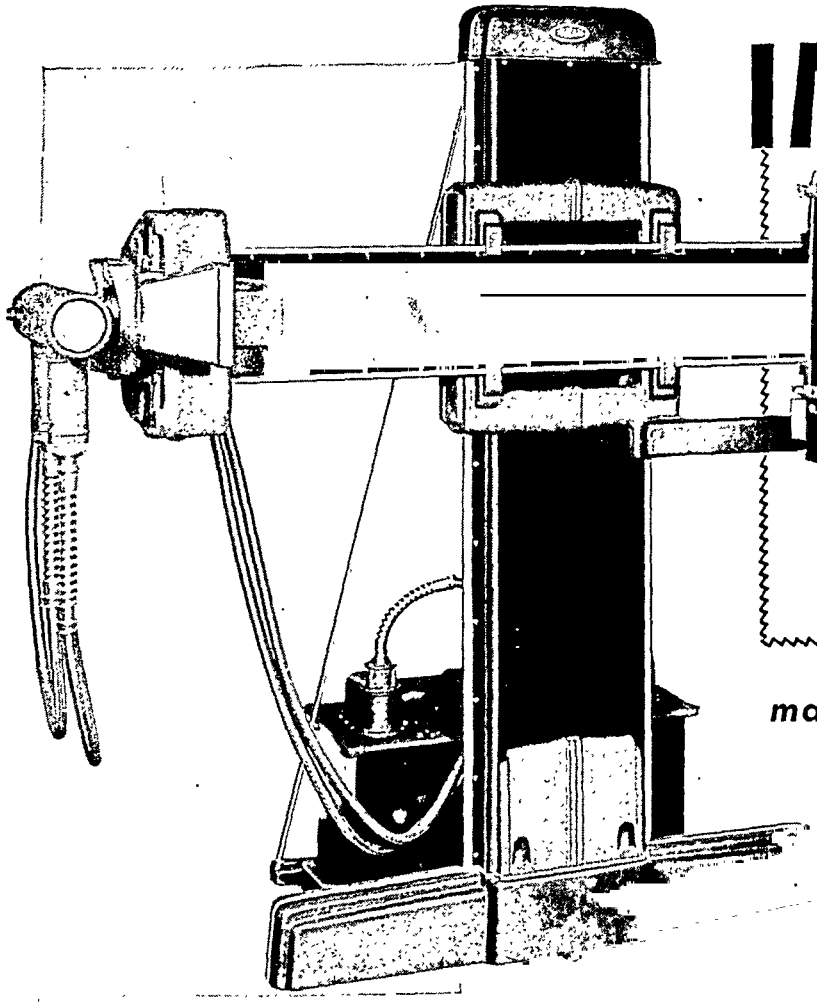
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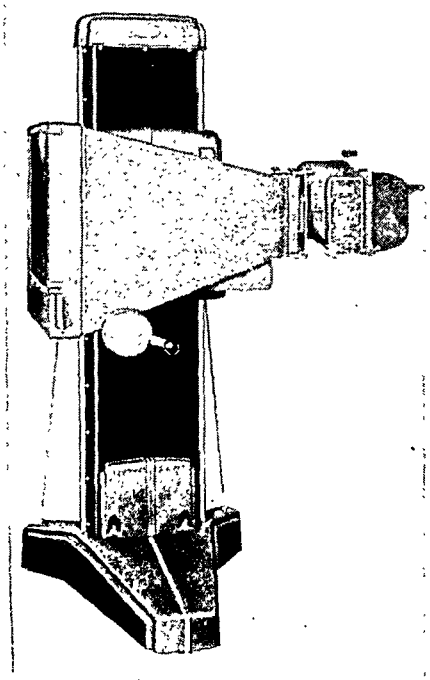
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THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

VOL. 60 OCTOBER, 1948 No. 4

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Manuscripts offered for publication and other correspondence relating to the editorial management and books for review should be sent to Dr. Lawrence Reynolds, Associate Editor, 110 Professional Building, Detroit 1, Michigan. Contributions may be sent in foreign languages and will be translated if found acceptable. Original articles are published with the understanding that they are contributed exclusively to THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY.

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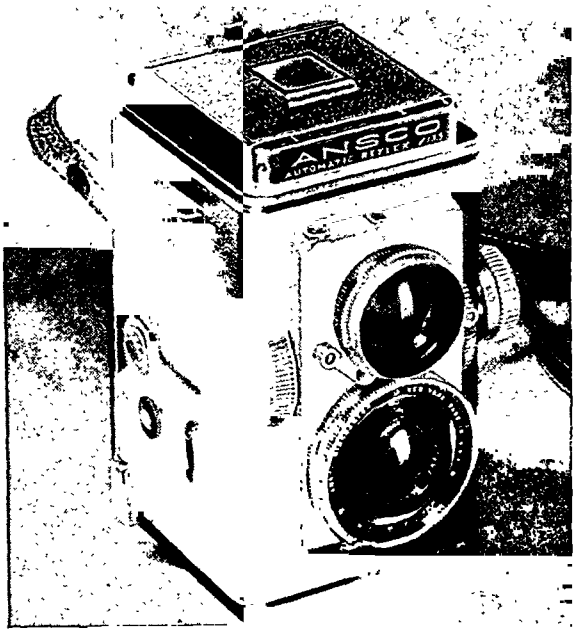
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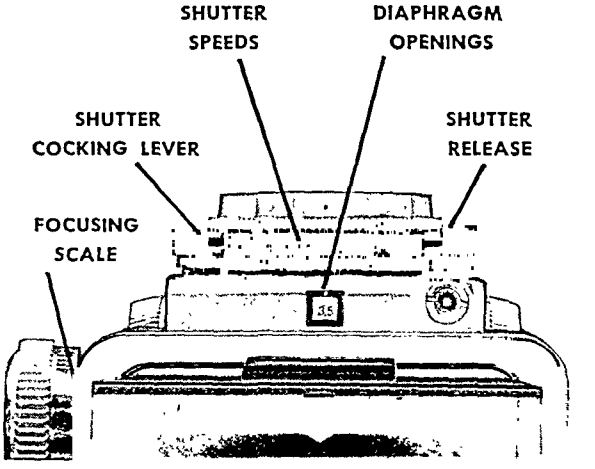


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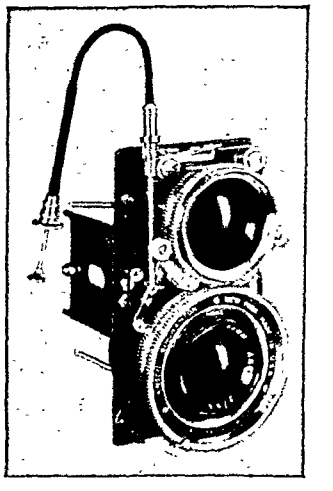
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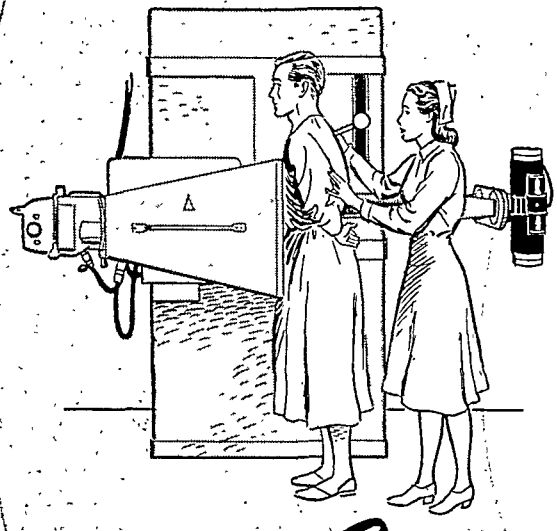
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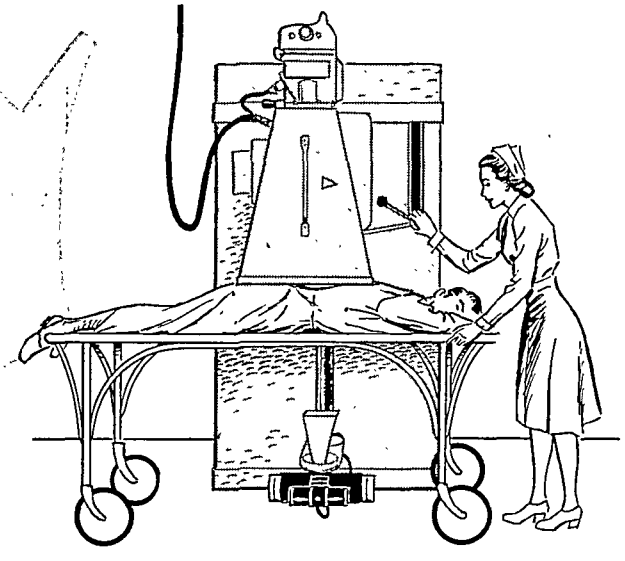
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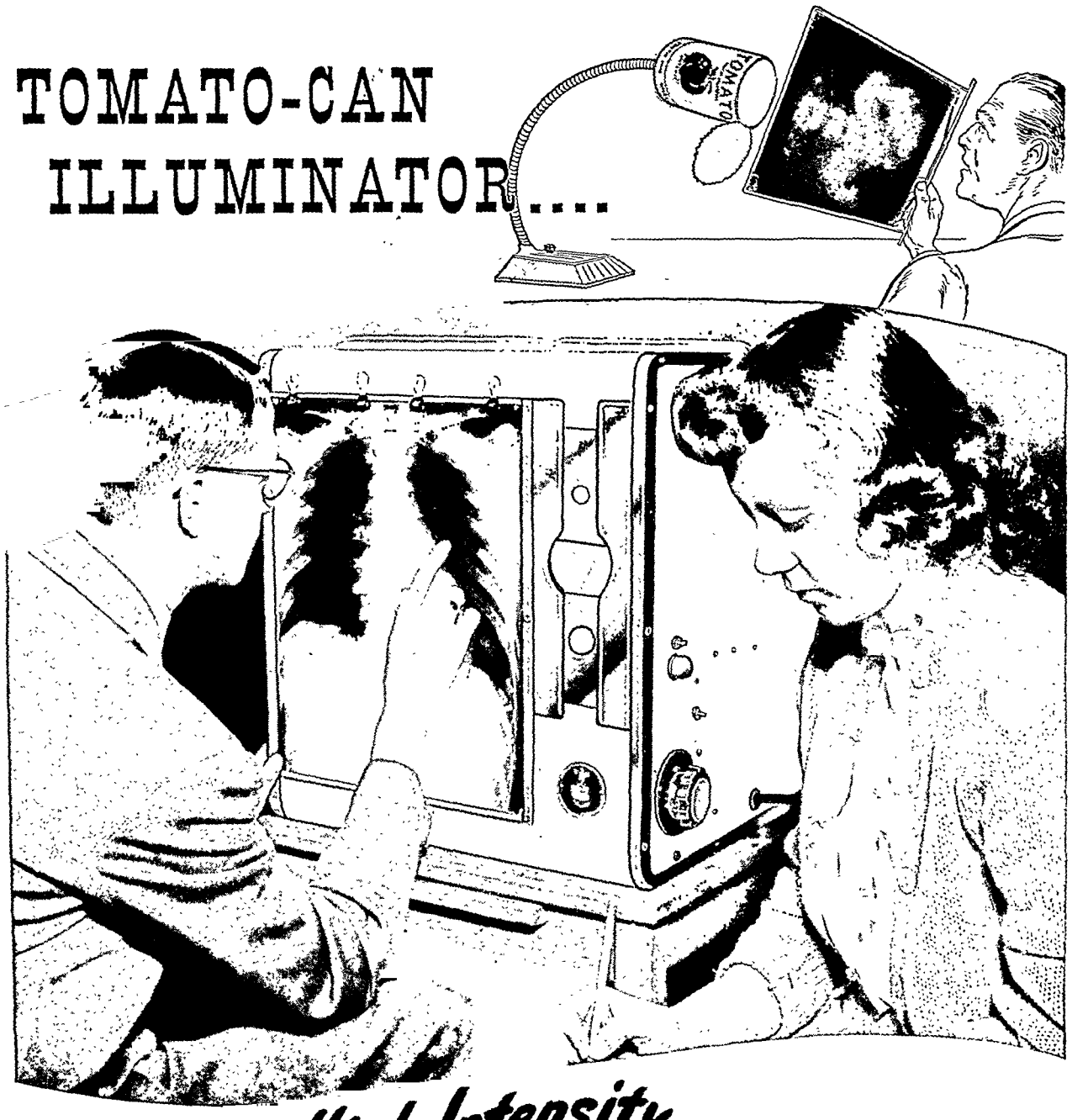
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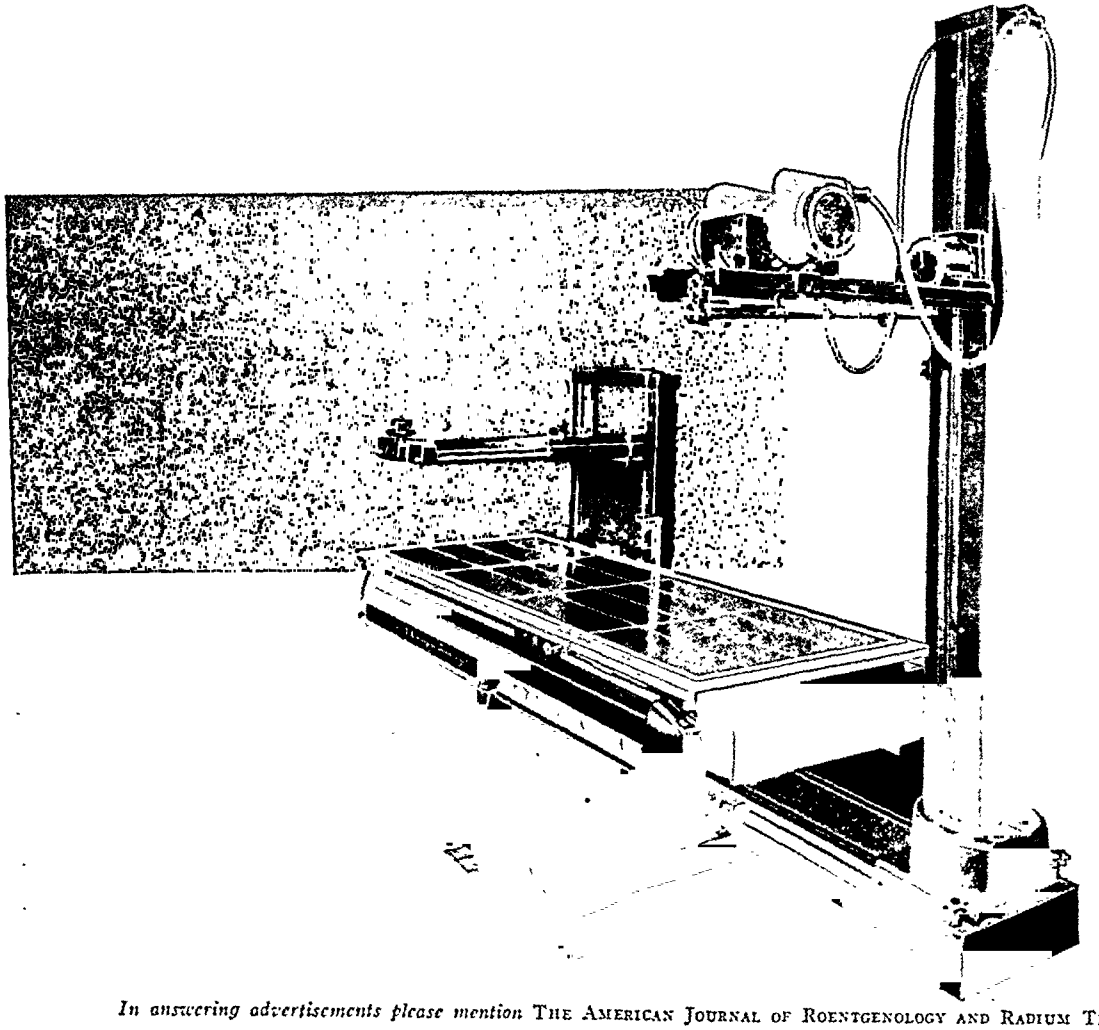
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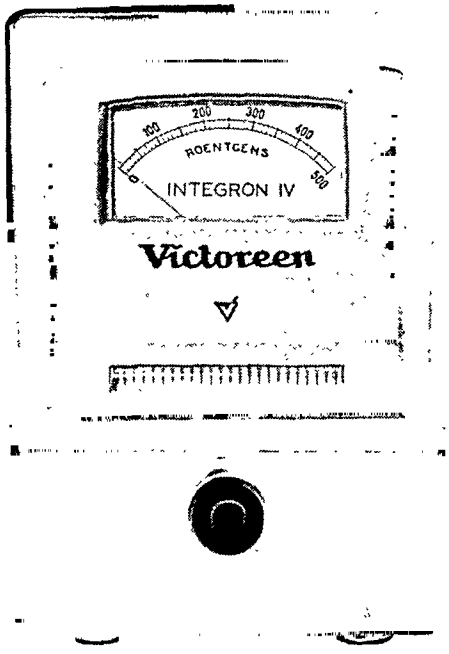
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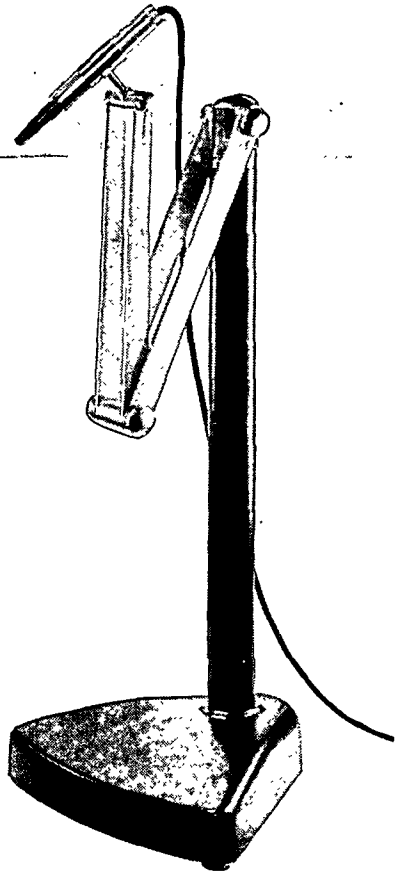




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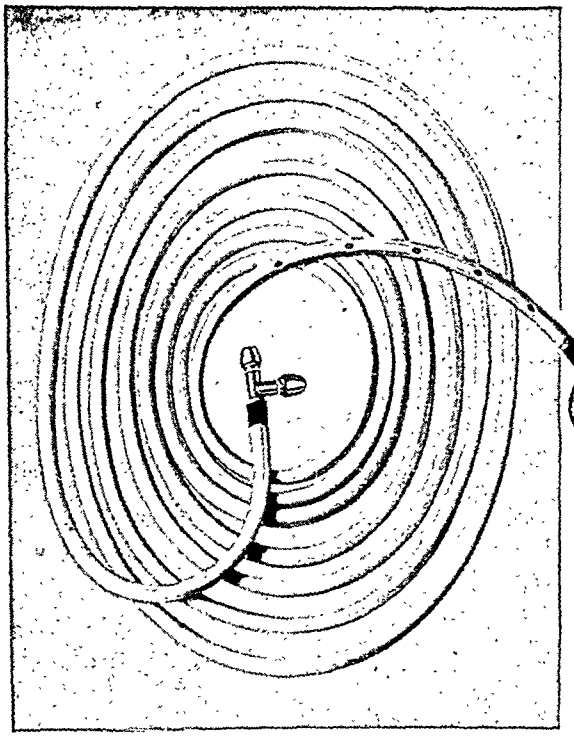
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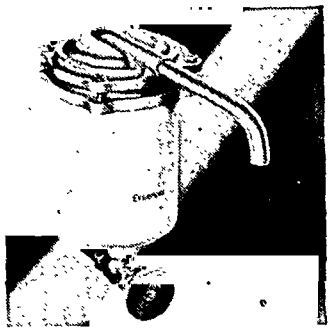
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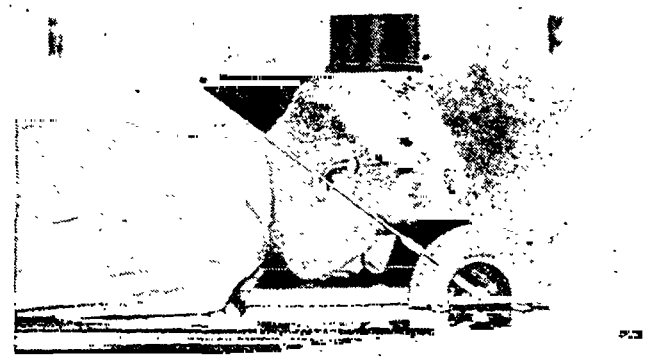
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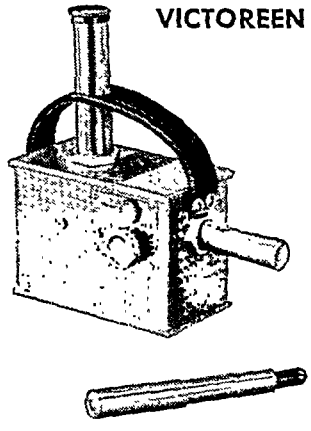


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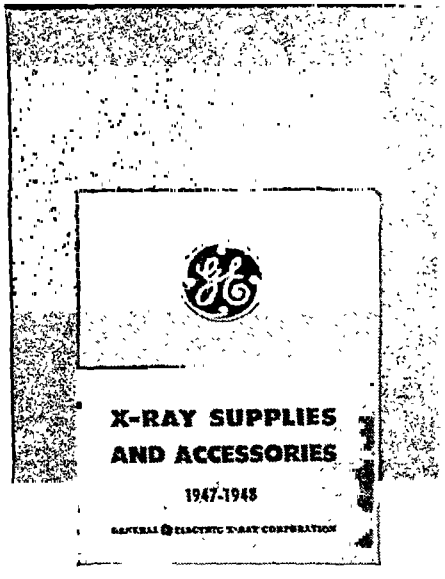
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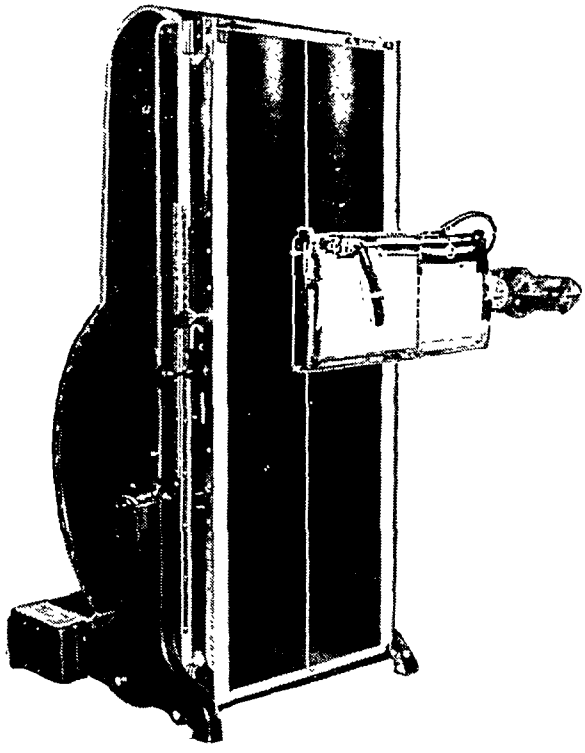
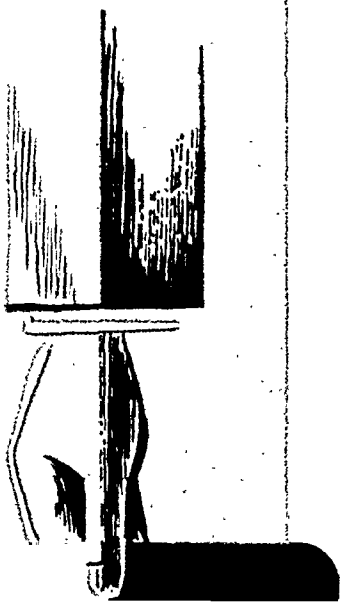


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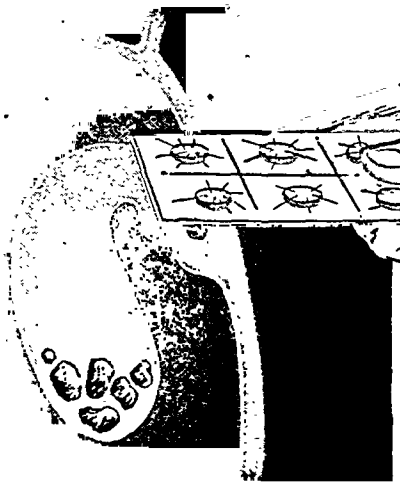


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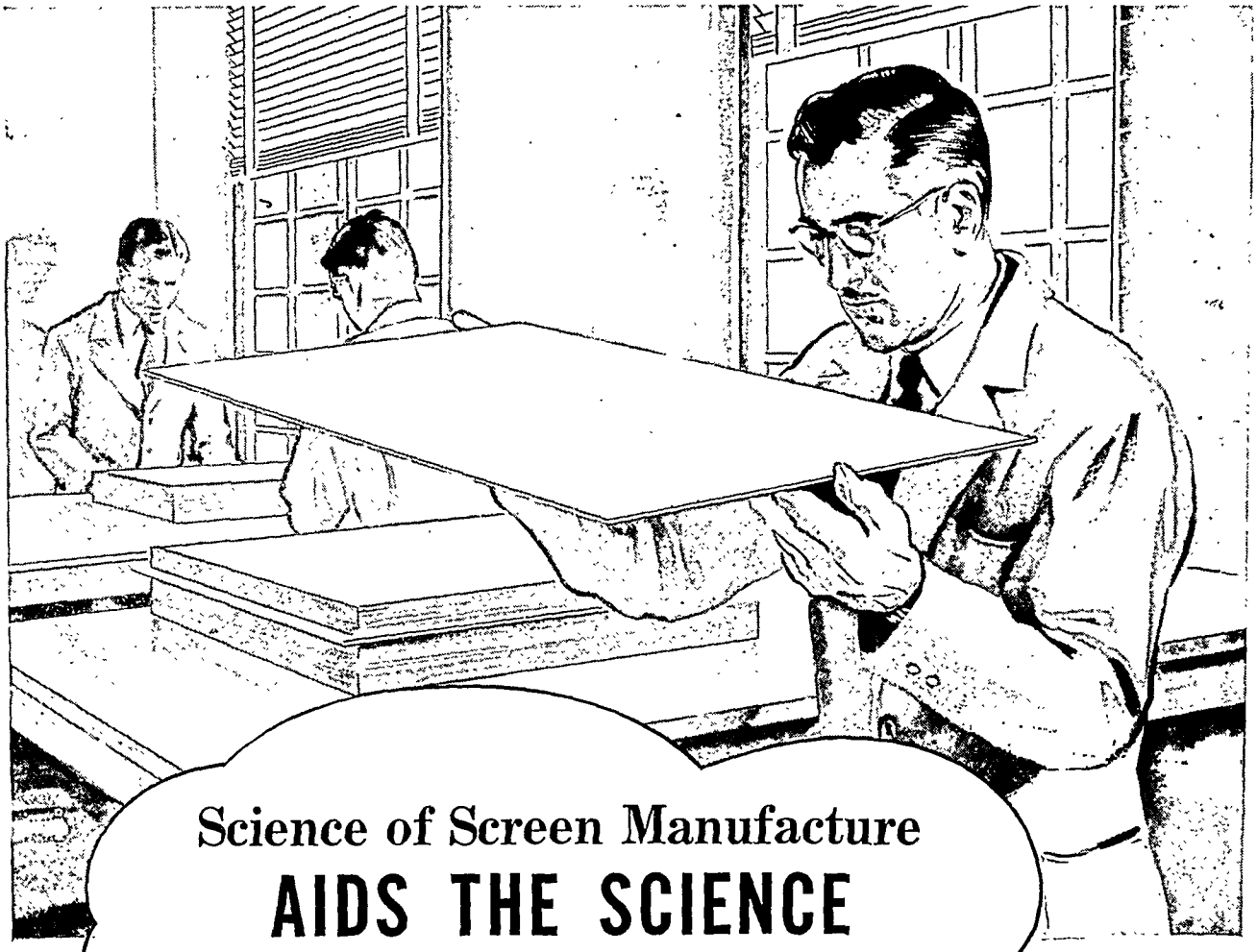
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PRESIDENT OF THE AMERICAN ROENTGEN RAY SOCIETY

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THE ROLE OF RADIOLOGY TODAY, ITS RESPONSIBILITY AND ITS IMPORT UPON OUR LIFE*

By LAWRENCE REYNOLDS, M.D.
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THIS Society has honored me far beyond my deserts. To be elected President of the American Roentgen Ray Society is an honor to be coveted, for is it not the oldest radiological society in this country, with a long array of brilliant scientific contributions and an unrelenting effort of well nigh fifty years, which, today, places it in the fore-front of accomplishment. It has not yet reached the fixed period; indeed, medicine never reaches that period of existence.

I shall not attempt to discuss the historical backgrounds of our Society; there are men in this audience who have seen it grow from the beginning and, therefore, as Aristotle says, "He who sees things grow from the beginning will have the finest view of them." I am one of the lowly ones and from that point of vantage I would like to discuss radiology's role today, its responsibility, and its import upon our life.

Medicine is a vessel which has been replenished from the treasury of enlightened minds. and when Röntgen poured his new kind of ray into this vessel little could he imagine the important effect on the world of science and the remarkable train of scientific events that have so closely followed. That branch of medicine known as radiology must boast that it more nearly approaches the example of Holmes' Chambered Nautilus for did it not begin as a unicellular plant, which could scarcely be dignified in those early days as a department, in some neglected room in the basement of the hospital. The early workers, by dint of sheer determination against all sorts of adversity and discouragement have elevated it from there to the high place it occupies in the hospital organization and in the practice of medicine. Today radiology stands at the crossroads of the corridors of the hospital forming the key-point from which knowledge is disseminated in many directions to the benefit of the patient and to the advance of medical progress. We owe a great debt to those who blazed the trail and laid the pathway over which we late comers travel so easily.

Who are these men of radiology who have contributed so fruitfully to its advancement? Many of them were members of this Society; members whose lives and work are

* President's Address delivered before the Forty-ninth Annual Meeting, American Roentgen Ray Society, Chicago, Illinois, September 14–17, 1948.

now matters of history—Williams, Caldwell, Dodd, Carman, Crane, Hickey, Pancoast, Ruggles, Baetjer, Manges, Pirie. Others are still with us to remind us of the youthfulness of our branch of medicine—Case, Cole, Percy Brown, Pfahler, Christie, Holmes, Stewart, Potter, Grier, Nichols, and a whole host of younger men whose names and works are familiar to all of us. These men and others like them have set the pattern for radiology; they are men steeped in the knowledge of medicine in general and their specialty in particular. Men who are wise in counsel and considered in their judgments; original and ingenious. They had to be. Were they not dealing with a wholly new instrument in diagnosis and therapy in a domain where there was no well ordered road map of experience to guide them? Men who have given and given freely of their knowledge and time that the science of radiology might advance. Many have been teachers of rare ability, leaving a school of younger men as an example of their instruction. If one would consult the bibliography of radiology, here he would find their names writ high in the worthwhile contributions on the most varied subjects. These men took the faint flicker on the fluorescent screen in Röntgen's laboratory and transmuted it into the fine profession which we know today.

The whole history of radiology from its incipiency to the present time is one of steady development. Perhaps no single episode which has resulted from a scientific endeavor has so greatly influenced the progress of the human race as the discovery of the roentgen ray and radium and there is no branch of medicine which has not benefited by their employment.

This places radiologists in a very privileged and enviable position. We must not be content merely to carry out the daily routine in our departments but we must devote some of our thought to the care of the patient of tomorrow. As physicians who have been in the vanguard of the advancement of modern physics, we now must take our share of responsibility in furthering new research methods for future investigations. Are we not in daily contact with the pathological processes, the unraveling of which gives an impetus to our imagination and to our endeavor? All too often a radiologist of splendid scientific ability finds himself engrossed in matters of administrative interest losing sight of the fact that the greater importance lies in the experimental approach toward the solution of some of the problems of disease which man is heir to.

To maintain high standards in a radiologic department, enough sufficiently trained associates must be available to share the burden of the routine. The radiologists themselves should be responsible for a thorough examination of the patient. The custom of delegating the radiographic work to technical assistants does not always serve the best purpose. There may be minimum requirements in a certain case calling for a set procedure, but the maximum requirements should be determined on the basis of the individual clinical findings. It is the duty of the radiologist to help arrive, if possible, at the proper diagnosis. To this end no effort should be spared. Too long has the radiologic department been the arena in which the economic battles of the hospital are fought. A much wiser course would be to let the accrued money remain in the department so that additional well trained men may be secured and technical equipment of the latest design obtained, thus insuring the best care of the patient.

We also must exert wisdom in the selection of the young men who come into the radiologic department for training. Each year medicine recruits into its ranks the very flower of our young manhood. These in turn enter our hospitals as interns and residents. From them we must choose the future radiologists. If we are to secure the best, it is important that we select men of high character, great intellectual ability, a

desire to work, and those who believe in the dignity of work; men who are willing to scorn delights and live laborious days—not men who are merely content to "toddle to a competancy." In short, superior, worthwhile men in medicine who have the vision to see the great future that lies ahead in radiology and its allied sciences. The late Dr. Manges said shortly before his death that he wished he were "a young man again just entering radiology"—a fine tribute to his branch of the profession to which he had himself, contributed so much.

The training of a radiologist you will hear discussed tomorrow evening* by one who is steeped in the knowledge of that subject.

Cannot radiology boast that it spawned other exciting and important professions—namely, aviation chemistry, radiotherapy, radiochemistry, atomic radiology, structural atomic radiation engineering; none of which would be if Röntgen, the Curies and Sir J. J. Thomson had not accelerated by leaps and bounds new knowledge in the world of charged particles.

History records the ebb and flow of civilization which led at last in the great days of Greece to the beginnings of science. "To one small people it was given to create the principle of progress; that people was the Greek. Except the blind forces of nature, nothing moves in this world which is not Greek in its origin," and Cournot, speaking of the atomic theory, says that "none of the ideas that antiquity has bequeathed to us has had a greater or even a similar success." Modern atomic theory is but the lengthening shadow of Leucippus and Democritus and our recent advances in the exploration of the atom is but an extension of their well ordered theory. And it was Pierre Gassendi, the French Dean and Prebendary, who finally introduced atomic theory into modern physics. So the atomic theory looks back on a long and eventful history culminating in the fall of the atomic bomb on Hiroshima and Nagasaki. We have reached the age of atomic fission which has given rise to a new science of non-static biology which, as Warren says, calls for revived concepts if man is to cope adequately with the perils of atomic warfare and to exploit radiation.

We have entered new fields of scientific investigation involving to a great degree relativity rather than the absolute with which scientists were accustomed to deal and as a result of the application of atomic fission in medical research science has come to regard the human being as an exquisitely constructed physiochemical mechanism, and among the most significant of its discoveries are those which are revealing the operations of man's bodily machine. The accumulated evidence from biology and the medical sciences shows that each of us is a biochemical system, elaborate beyond the ability of science to analyze as yet. No longer can the human body be considered as static and precise but as dynamic and constantly changing. So the day of human exploration has begun utilizing the most modern of physical and chemical methods. And we are told in flaming headlines that microbes are being pounded by radioactive atoms in an attack on the secrets of life's beginnings, and the work is starting with a microbe known as *E. coli*, one of the most common forms of bacteria, and an organism or one very closely resembling it, which came into existence about five hundred million years ago.

The products of atomic fission are being used to discover how the human body converts food into fat, flesh and energy and how it repairs injuries and how radioactive isotopes seek out specific tissues and flood them with rays which in some cases have extraordinary healing power, and the biologists are using them in other scientific efforts to catch the green leaf in the very act of making starch, sugar and cellulose with the aid of the sun. By the use of the products of atomic fission great progress is being made in illuminating some of the

* The Caldwell Lecture, "Graduate Education in Radiology," by B. R. Kirklin.

darker regions of physiology and chemistry.

Not only is atomic energy being used to elucidate many unknown problems, but it is creating additional problems to be solved. For instance, the medical problems arising from the explosion of a nuclear fission bomb over a modern city will be vast to the point of being almost overwhelming at the beginning and will continue for a period of years.

Radioisotopes today in their relation to general medicine are very much in the same position as radiology was fifty years ago. It began as a tool of the physicist and by gradual expansion in its medical application it became a department within itself. Is it not logical that radiant energy should also fall within the specialty of radiology, and is not that the safest department in the hospital within which it should fall, as the hazards of atomic fission are comparable to those of the roentgen ray? Since the radiologist has learned over long experience the ill effects from unguarded radiation, might not he in that capacity be better able to safeguard not only the patient but also those working with radioisotopes?

It might be argued, and rightly so, that the radiologist is not always equipped with a sufficient knowledge of nuclear physics to carry the burden and added responsibility of this important new form of radiant energy unless he is so fortunate as to have in association with him a well trained physicist. Indeed, in a modern radiological department such an association is not only justifiable but necessary. Certainly until the radiologist of the future is properly trained in medical physics there is no alternative.

Since the government has made available, in unlimited quantities, radioisotopes both for research and therapy, there is opened up a wide field of investigation. With the generous grants that are being made both by the National Research Council and the Research Division of the American Cancer Society, grants which are made not only to the universities but to well equipped and staffed departments in some of the smaller institutions, it behooves us as a Society to see that such grants and aids are utilized to the greatest advantage. Not all of the important discoveries which have led to advances in medicine have been made in marble halls. Many of them have come from relatively obscure departments equipped for the most part with intelligence. Therefore, the National Research Council and the American Cancer Society have pursued a wise policy in the generous consideration of some of the smaller institutions. Who knows but that out of such generosity may come things of great importance! The discovery of the cause of cancer is not, as we are led to believe, just around the corner, but the vast accumulation of knowledge of the normal as well as the abnormal may ultimately lead to the clue which will unravel the riddle.

The headlong, almost untrammeled, advances of science in its search for truth has led us into perilous situations. Man himself is unable to keep pace with the advances in the scientific world, and we have become a one-sided individual. What boots it if in our scientific endeavor we are able to unravel the biological and physical aspects of man if we lose the soul itself? With the unbridled search for truth we are in the act of destroying what some call the *illusions* of life and we are suddenly faced with the stark realities, being reduced to a mere mechanism. We lose some of the finer characteristics which civilization has built up over the thousands of years and there is great need for a re-establishment of values in life. At the end of World War I Sir William Osler in his brilliant address before the Classical Society of Oxford on "The Old Humanities and the New Science" made a plea for the introduction of a study of science in the humanities in order to show the part that it played in the advancement of civilization. He pointed out that "no man is cultivated up to the standard of his generation who has not an appreciation of how the achievements of the human

mind have been reached; and the practical question is how to introduce such studies into the course of liberal education, how to give the science school the leaven of an old philosophy, how to leaven the old philosophical school with the thoughts of science."

The wheel has turned full cycle and now, at the end of World War II, the tread of the march of science has muffled to a faint whisper the Old Humanities in the corridors of our halls of learning, and we men of medicine and science must participate in the revival of the humanities, if civilization as you and I know it is to continue.

These are thoughts on things, thoughts though lightly touched upon.

TRAUMATIC BRONCHIAL RUPTURE WITH OCCLUSION*

By PHILIP J. HODES, M.D., JULIAN JOHNSON, M.D., *and* JOSEPH P. ATKINS, M.D.
PHILADELPHIA, PENNSYLVANIA

BRONCHIAL tears are not common. Usually due to crushing chest injuries, they are often fatal. When patients survive this injury, they may develop complete bronchial occlusion and pulmonary collapse.

A patient who sustained a torn bronchus with subsequent pulmonary collapse was recently examined and treated in the Hospital of the University of Pennsylvania. Whereas post-traumatic bronchial occlusion was thought of, other possibilities seemed more probable to those of us unfamiliar with the condition. When the patient was operated upon, he proved to have an occluded bronchus due to trauma.

The purpose of the present communication is to record our findings in this patient. In addition, the literature pertaining to this subject is reviewed.

CASE REPORT

G.M., male, aged thirty-six, was admitted to the Hospital of the University of Pennsylvania on February 20, 1946, complaining of severe dyspnea of two days' duration. He had been perfectly well until October 5, 1945, when he was severely injured by a racing automobile that jumped the track and entered the viewing stands. He was hospitalized immediately and was unconscious for four days.

The patient's chest was first examined roentgenographically ten days after the accident, on October 15, 1945 (Fig. 1*A*). The single anteroposterior view of the chest revealed the following: Moderate interstitial emphysema extended throughout the right lateral chest wall and into the neck on the same side. The right first rib was fractured in its paravertebral region. The trachea was in the midline. The heart and aorta seemed unaffected. The right hemidiaphragm was somewhat elevated, the left was normally placed. A pneumothorax was noted on the right side with approximately 35 per cent collapse of the right lung. The left lung was normal.

A mild cough and moderate dyspnea were noted at that time.

The patient improved rapidly. His chest was again roentgenographed on October 27, 1945, at which time the following was noted (Fig. 1*B*): The general appearance of the chest revealed considerable improvement. Interstitial emphysema and pneumothorax were no longer evident. The elevated right hemidiaphragm was still present. The lungs appeared clear. (It is noteworthy that this patient was in the Navy for two years prior to his injury and probably had a healthy chest at that time.)

Slight substernal distress and mild dyspnea persisted after the patient left the hospital in October, 1945. The dyspnea reached its peak in December, 1945, when vertigo was also noted. It was not until February 18, 1946, however, that he suffered real respiratory embarrassment. At that time, he suddenly became orthopneic and sought the help of a physician.

Physical examination that evening revealed complete collapse of the right lung. He was immediately roentgenographed and the clinical impression confirmed. Roentgenograms of the chest taken February 18, 1946, four months after his original accident, revealed complete collapse of the right lung with marked deviation of the mediastinal structures to the right side.

On admission to the Hospital of the University of Pennsylvania the physical examination was negative except for the findings in his chest. The trachea was displaced markedly toward the right. The left chest was hyperresonant whereas the right was dull, particularly at its base. Whistling breath sounds were heard over the right lung. The apex of the heart seemed close to the midline.

The patient's blood studies and urine analysis were normal. The red blood cell count was 4,000,000, the hemoglobin 85 per cent. The white blood cell count varied between 4,800 and 9,100, with 60 per cent neutrophils, 2 per cent

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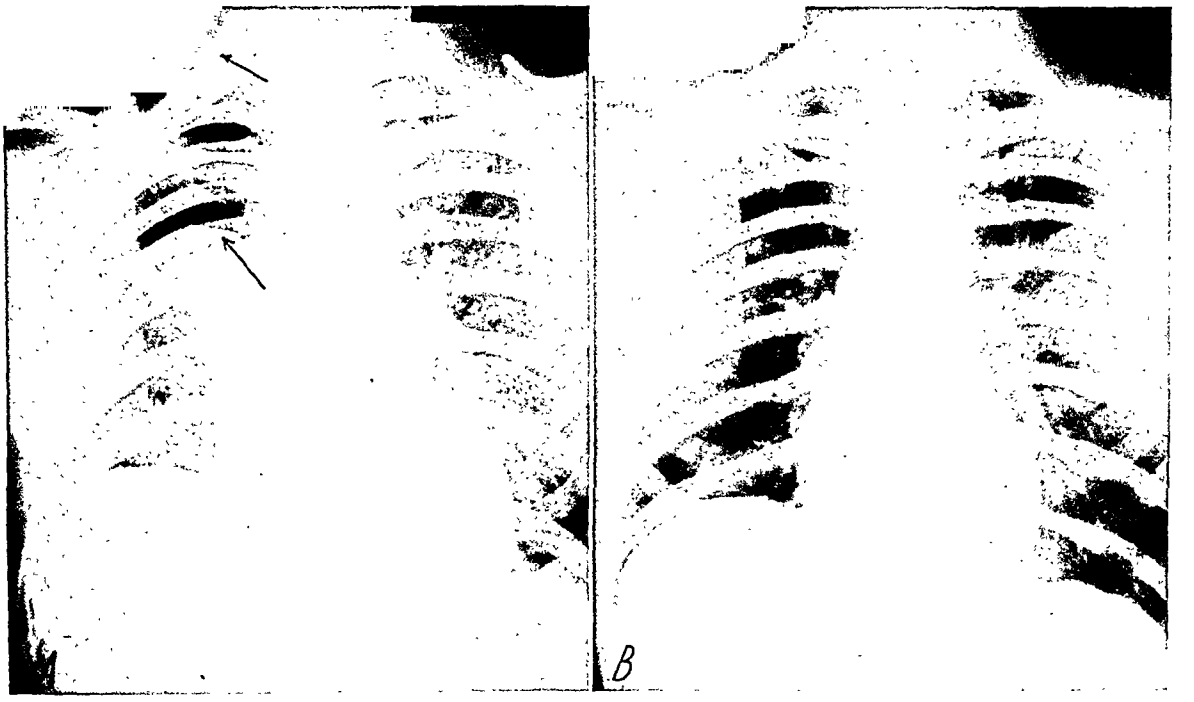


Fig. 1. *A*, roentgenogram obtained October 15, 1945, ten days after injury. The right lung is partially collapsed. Note the fractured first rib and elevated right hemidiaphragm. *B*, roentgenogram obtained October 27, 1945. The right lung has re-expanded completely. (Roentgenograms courtesy of Dr. John Harris.)



Fig. 2. (Same patient as Fig. 1) *A*, roentgenogram obtained February 22, 1946, after onset of severe dyspnea. The right lung is completely collapsed. *B*, this is a portion of the Potter-Bucky roentgenogram of the chest taken the same day. The deviated trachea is clearly defined. The obstructed right stem bronchus is seen at the arrow.

eosinophils, 4 per cent monocytes and 34 per cent lymphocytes. The blood Kolmer and Kline reactions were negative. The electrocardiogram was normal.

The patient's chest was first examined roentgenographically in the Hospital of the University of Pennsylvania on February 22, 1946, when the following was recorded (Fig. 2): "The soft tissues of the thoracic cage reveal no

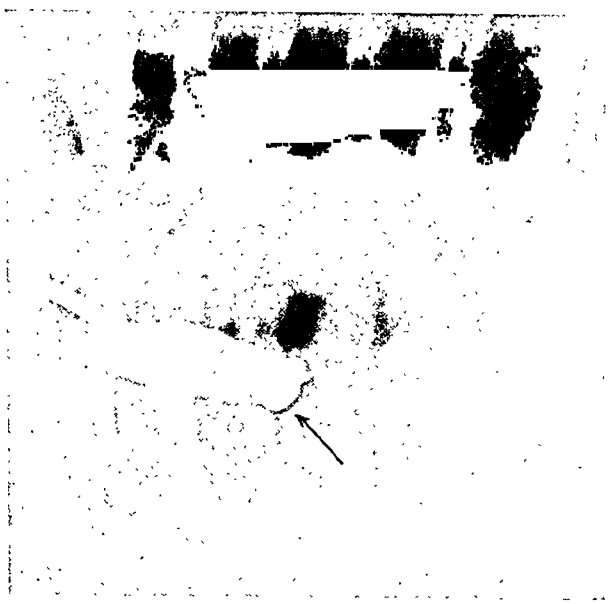


Fig. 3. (Same patient as in Figs. 1 and 2) Postero-anterior spot roentgenogram of the chest made with the patient lying in the right lateral decubitus position on March 6, 1946. The tip of the catheter lies in the blind pouch of the obstructed right bronchus. The bronchial obstruction is outlined by lipiodol, some of which is in the trachea.

abnormalities. There is an old fracture of the first rib on the right which is well united in adequate position. The configuration and alignment of the ribs are symmetrical. The trachea is displaced markedly to the right side. The heart and aorta lie almost entirely in the right hemithorax. The left hemidiaphragm seems depressed, the right cannot be delineated. The entire right lung is completely collapsed and the right half of the thoracic cage dense. The right main stem bronchus is occluded just beyond the carina. The latter is displaced toward the right and slightly upward. Distributed throughout the collapsed right lung are multiple calcified densities which may be the remnants of old calcified tuberculous foci. The left lung is emphysematous and clear."

The first bronchoscopy was performed on February 22, 1946, also, when the following was noted: "Bronchoscopic examination discloses the right main bronchus to be occluded by what appears to be a hard tumor mass. There is no definite fungating tissue and only a very superficial piece could be removed for biopsy. Careful search was made for a lumen into the remainder of the right side of the tracheobronchial tree, but none could be found. There is no evidence of suppuration. The bronchus on the left side is thick but not deformed. Secretion was submitted for bacteriologic examination."

On March 6, 1946, after a second bronchoscopy, which confirmed the original findings, a catheter was introduced through the larynx and trachea into the blind end of the right main stem bronchus. Then, under roentgenoscopic control, with the patient lying in the right lateral decubitus position, lipiodol was injected into the right side. Roentgenoscopically, the bronchial occlusion seemed complete. Recording spot roentgenograms were made with the patient lying first on his right side and then in every other position. These were reported as follows: "The films confirm the presence of a complete block of the main stem bronchus on the right side. We are impressed by the fact that the obstruction seems smooth in contour rather than irregular as one would expect in a lesion within the bronchus producing occlusion (Fig. 3). We believe that we may be dealing with a stenosing process around the bronchus which cuts it off."

On March 8, 1946, a third bronchoscopy was done and the following recorded: "Bronchoscopic examination reveals no change in the findings as previously noted. It would appear that about 1 cm. of the right upper lobe bronchus remains and ends abruptly at that point. Further small piece of tissue was removed for examination."

Smears and cultures taken directly from the occluded bronchus bronchoscopically revealed rare alpha prime streptococci, viridans and non-non-hemolytic streptococci, and *Staphylococcus albus*.

Histopathologic study of the biopsy sections taken from the base of the blind pouch were reported by Dr. Robert Horn to "consist of cartilage surrounded by areas of fibrous tissue containing mucous glands. The glands are lined by a single layer of cells, their nuclei being close to the periphery of the gland. The cartilage appears normal. Conclusion: Bronchus."

The patient was operated upon March 15,

1946, under endotracheal anesthesia. At operation the right lung was found completely collapsed. No tumor mass could be palpated. The great vessels of the right hilum were isolated and ligated and a pneumonectomy performed.

After the right lung was removed, the remaining portion of the right bronchus was identified and sectioned. One inch proximal to the point at which the bronchus had been amputated "a thin smooth red membrane lay stretched across the lumen of the bronchus that looked like normal bronchial mucosa with some element of scar tissue. The obstructing membrane had none of the characteristics of tumor. So complete was the obstruction that it was not necessary to close the bronchus itself."

The pathologist's description of the resected right lung follows:

"*Gross Description:* The specimen is a right lung the over-all dimensions of which are 20 by 14 by 3.5 cm. The surface is dark reddish-blue. Crepitus is not demonstrated and the tissue does not float on water. Edematous fluid cannot be expressed from the tissue. A calcified nodule is present on the base of the upper lobe measuring 2.0 cm. in greatest diameter. Another somewhat smaller calcified node is found in the hilar region. Although the bronchi are filled with a clear viscid substance, no extrinsic or intrinsic obstructive lesion is demonstrated and the bronchi appear grossly normal. A few, dark, almost black, soft nodules are present on the pleural surface measuring 1.5 cm. in greatest diameter. On frozen section they appear to be anthracotic nodules. No other local lesion can be demonstrated in the parenchyma. A segment of main stem bronchus is submitted separately. The bronchus is 1.5 cm. in diameter and the segment is 2 cm. long. The wall is thickened and mucosal folds are present which appear to radiate toward one area. A rib is also submitted which appears normal. No sections are taken from the rib.

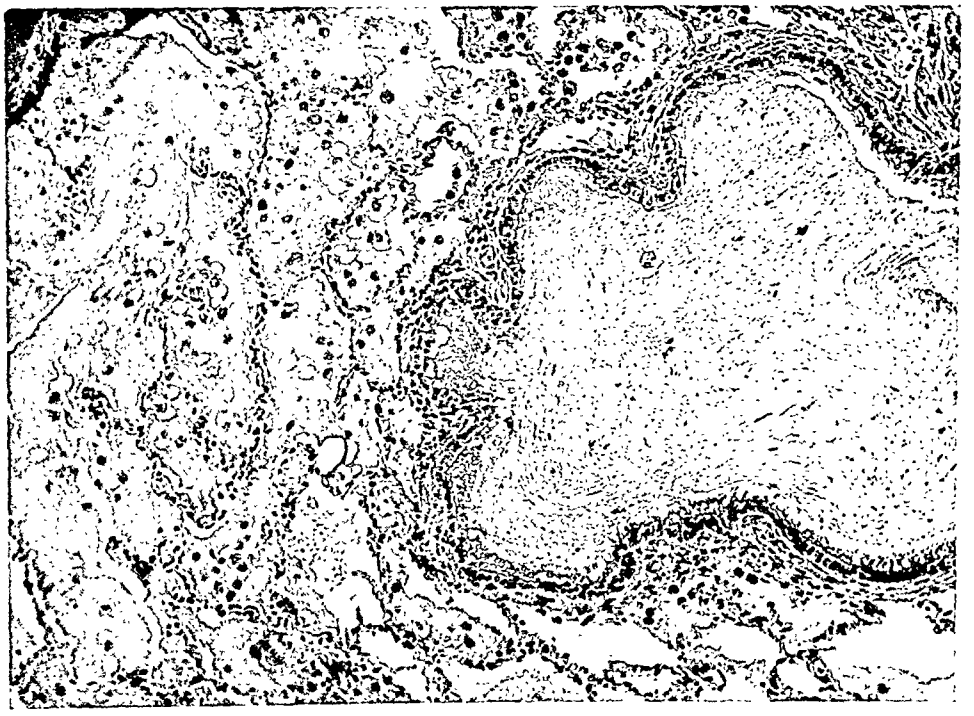


Fig. 4. Photomicrograph of a portion of the right lung removed at operation. The bronchiole is partially collapsed. Many alveoli are also collapsed. Note secretion and cellular debris in the bronchus and alveoli.

"*Microscopic:* (Fig. 4) The sections of bronchus reveal normal bronchial constituents. The mucosa is composed of well preserved dilated columnar epithelial cells. Smooth muscle and cartilage are present and appear essentially normal.

"The lung itself is atelectatic with partial collapse of most alveoli. Many phagocytes distended with a yellowish-brown pigment are present. The interstitial areas are sites of mononuclear inflammatory cell collections, while in

small areas, polymorphonuclear leukocytes are seen.

"Many erythrocytes and much edematous fluid are seen within the alveoli. The dark lesion described grossly is a small lymphoid nodule with much anthracotic pigment seen in the phagocytes of the reticular elements. Mucin is present in many of the smaller bronchi and bronchioles. There is no evidence of malignancy.

"*Diagnosis:* Atelectasis of right lung; cicatrix of right main stem bronchus (with occlusion). (Signed) Dr. Robert C. Horn."

When last examined in June, 1946, the patient was asymptomatic.

REVIEW OF LITERATURE

One of the first patients reported in the English literature with a torn bronchus was recorded by Sheild[16] in 1889.* His patient was caught between a van pole and a wall. Several ribs were broken and forced into the anterior mediastinum tearing the left main bronchus near the carina. The patient died soon thereafter.

In 1906 Barford[1] reported a four year old boy who died of a torn bronchus forty-five minutes after being run over by a van. Autopsy revealed several broken ribs and a torn left stem bronchus just distal to the carina.

King,[5] in 1907, reporting on "Medical and Surgical Practice in the Hospitals and Asylums of the British Empire" described the events leading to death in a four year old child who also had a torn bronchus. His description was so graphic, it seemed well worth recalling at the present time.

An hour before admission the child had been knocked down by a brougham, rubber tyred. Whilst on the way to the hospital she had coughed up blood several times. On admission, the child was very collapsed, the temperature being subnormal, and the pulse running; there was no cyanosis and the respiration rate was 28 per minute.

The fifth to eighth ribs were found to be fractured on the left side, the ribs on the right side being intact. It was noted that the movement on the right side of the chest was very deficient, respiration being mainly carried on by the left (the injured side). As any attempt at moving caused haemoptysis, the back of the lungs could not be examined; blood was brought up four times on the day of admission.

The third day after admission, the child seemed much worse. The pulse and temperature were rising and cyanosis was present; the physical signs remained the same. The right pleural cavity was considered to be distended with air under a positive pressure. With a view of relieving this, the right side of the chest was punctured below the angle of the scapula with a fine trocar and cannula, the cannula being connected with a rubber tube, the distal end of which was kept under sterilized water. When turned on to the left side preparatory to making the puncture, the child coughed up a large quantity of red blood, none having been ejected during the previous twenty-four hours. The result of the puncture was an escape of air which bubbled up through the water; for the first few seconds the escape was continuous during both expiration and inspiration, but after a few seconds the air escaped during expiration only. During inspiration, there was no negative pressure, as evidenced by the fact that water did not tend to be sucked up the tube. After a few minutes, the cannula was removed, and the puncture sealed with gauze and collodion. During the day the child rapidly became worse and died at 10 P.M., fifty-five hours after the accident.

On opening the thorax the right pleural cavity presented the appearance of a large open space, the lung being completely collapsed. The pleural cavity contained about 2 oz. of blood. There was no laceration of the parietal or visceral pleurae except for a small rent over the root of the lung. On the left side the pleurae were intact.

The right lung was completely collapsed and airless, all portions sinking in water. There was a complete transverse rupture of the right main bronchus ½ in. from the bifurcation of the trachea. The pulmonary artery and vein were intact. The left lung was normal.

The same year, 1907, Moty and Guibal[11] published one of the earliest bilateral bronchial tears recorded in the literature. Their patient, a French cavalryman, was jolted from his horse-drawn cannon and run over by one of its wheels while on maneuvers at Verdun. His chest was crushed and he died in about ten minutes. Autopsy revealed tears in both main stem bronchi close to the trachea.

In 1907, May and Bowen[9] also reported a patient with a ruptured bronchus who died in twenty-six hours. Their patient's head was run over by a wagon which caused bilateral skull fractures. Whereas this patient's right stem bronchus was found severed just below the carina at autopsy, there was no evidence of damage to the bones of the thoracic cage, pleura or hilar vessels.

Several years later, 1912, Leckie[8] reported one of the first motor car accidents to produce a

* Sheild referred in this brief discussion to similar bronchial tears reported by others previously.

torn bronchus. His patient lived eight hours after his chest injury.

The first complete review of the subject also appeared in 1912, published by Schonberg.[15] He reviewed the patients reported by King,[5] Moty and Guibal,[11] and Leckie,[8] added to these 10 others he found in the literature, and described 3 additional new cases of his own.

Patrick[13] recorded a soldier in 1917 who died in seventy-two hours of a torn left stem bronchus. At autopsy fractured ribs, a broken sternum, and acute pericarditis were found in addition to the injured bronchus.

Lilienthal's book on "Thoracic Surgery," published in 1925, contains a personal communication from Major W. C. Thomas,[17] United States Army, describing a bronchial tear in a soldier who was crushed beneath an overturned coal wagon. He died suddenly nine and one-half hours after being hurt.

Probably the first patient known to have recovered from such an injury was reported in 1928 by Krinitzki.[7] The diagnosis was made at autopsy twenty-one years following the accident. The right main stem bronchus terminated in a blind pouch 3 cm. from the tracheal bifurcation.

Meade and Graham[10] published another fatal case in 1930. Their patient fell from the fender of a truck and was pinned between the vehicle and the road bank. He died in sixteen hours of a transverse rupture of the right main bronchus 5 cm. below the carina.

In 1936, Nicod and Urech[12] described their findings in a cavalry officer who fell from his horse and was crushed. This patient recovered and remained well for ten years when he died suddenly of a hemorrhage from esophageal varices complicating hepatic cirrhosis. His left bronchus was torn and sealed near the carina at autopsy.

Rienhoff,[14] discussing in 1936 the readjustments that occur in the chest following pneumonectomy, made reference to 2 patients upon whom he had operated and found post-traumatic "pulmonary atrophy." The first patient was injured at nine years of age and was operated upon twenty years later. The second was hurt at the age of three and was operated upon thirty-two years later.

In 1939, Jones and Vinson[4] followed a patient with a ruptured bronchus almost from the moment she was injured until she left the hospital with a completely collapsed left lung fourteen days later.

On admission to the hospital, physical examination of Jones and Vinson's patient revealed bilateral limitation of respiration, a tympanitic percussion note over both sides of the chest, and marked mediastinal shift to the left. Interstitial emphysema developed within five minutes and spread rapidly from the head and face to the abdomen, shoulders and arms. The dyspnea was intolerable. The systolic blood pressure dropped to 60, the pulse became thready and over 180 a minute, marked cyanosis developed and the patient lapsed into unconsciousness.

A short incision was made in the suprasternal notch and the dissection carried into the superior mediastinum behind the manubrium releasing large quantities of air. About 700 cc. of air was then withdrawn from the left hemithorax through a small needle cannula inserted between the ribs by reversing the flow of air in a pneumothorax apparatus. The same procedure was employed on the right side with the aspiration of 7,000 cc. of air. The initial pressure in the left hemithorax was plus 2 cm. of water; the final pressure minus 4 cm. of water. On the right side of the initial pressure was plus 4 cm. of water; the final pressure minus 3 cm. of water.

Following these procedures, plus artificial respiration, the patient began to breathe more easily, lost her cyanosis, and regained consciousness. The pulse rate dropped to 130, the systolic blood pressure rose to 105.

Within thirty minutes, the patient again lapsed into unconsciousness with dyspnea and cyanosis. This time a silver cannula was placed between the ribs into the right pleural cavity which released several liters of air under pressure. The cannula was strapped in place and covered with rubber dam which allowed air to leave the chest without sucking air back into the thoracic cavity. More air was then aspirated from the left thorax.

The patient's condition gradually improved until the morning of the third day of her illness when the mediastinum suddenly shifted to the left with marked respiratory embarrassment. Complete atelectasis of the left lung seemed present.

The patient left the hospital on the fourteenth day apparently well. Her left lung was completely collapsed, the right was healthy. She was bronchoscoped at this time and a longitudinal area of necrosis was found on the posterior wall of the left main bronchus begin-

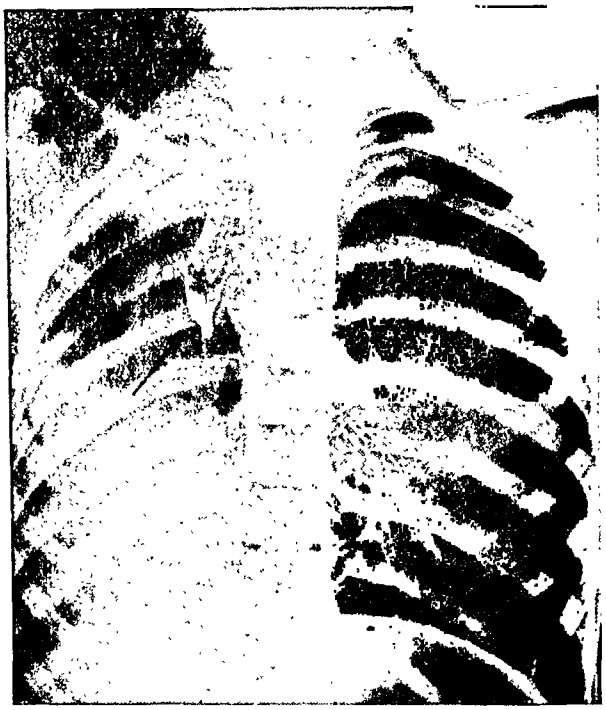


FIG. 5. Taken from Dr. Louis H. Clerf's original manuscript[3] with his permission reveals traumatic bronchial occlusion in a nine year old boy five years after a severe crushing injury to the right chest.



FIG. 6. Taken from Dr. Louis H. Clerf's original manuscript[3] with his permission reveals occluded left stem bronchus in a man, aged thirty-one, who complained of dyspnea and oppression in the left hemithorax. He had been in an automobile accident four months previously.

ning at the carina extending 3.6 cm. to a healing bronchial stricture measuring 2 mm. in diameter.

Clerf,[3] in 1940, called attention to 2 patients (Fig. 5 and 6) with bronchial atresia and atelectasis following chest injury, one of whom he saw four months after an automobile accident and the second five years after the accident. The former, a male, aged thirty-one, appeared

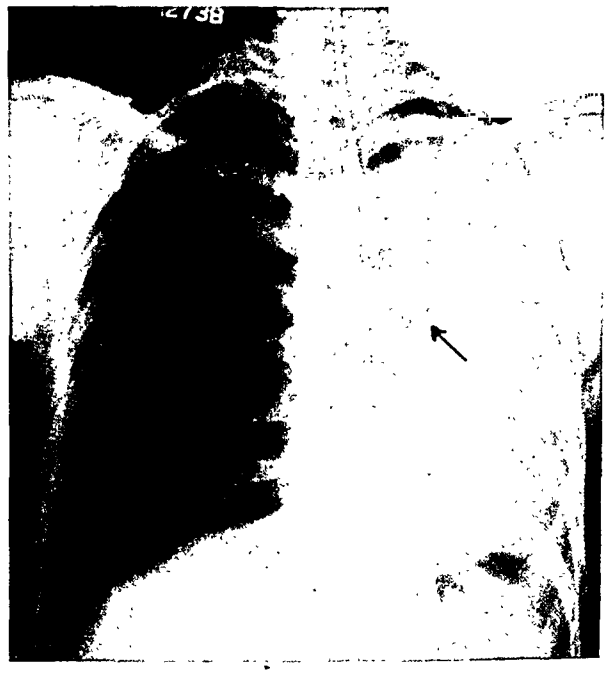


FIG. 7. Illustration from Tyson and Lyle[18] reproduced with their permission. The blind pouch in this obstructed left stem bronchus is filled with lipiodol. This roentgenogram was obtained four months after an automobile accident.

in excellent condition except for dyspnea on exertion. His left main bronchus terminated in a blind pouch 4 cm. beyond the carina. At bronchoscopy, the mucosa appeared slightly pitted, but no bronchial orifice or other communication could be observed. The second patient, a boy aged nine years, had no complaints. He was admitted for study, prior to tonsillectomy, to determine whether a general anesthetic could be safely administered. When last examined, thirteen years after his accident, he appeared perfectly normal.

One of the more recent reports dealing with this subject was published in 1942 by Tyson and Lyle.[18] Their patient (Fig. 7), a male, aged twenty-six, was admitted to the Mary Hitchcock Memorial Hospital four months after a serious automobile accident. His chief complaints included loss of weight, pain in the

chest, and dyspnea. Bronchography revealed complete occlusion of the left bronchus 3 cm. distal to the carina. Bronchoscopy revealed a blind pouch lined by normal bronchial mucosa.

When first seen by Tyson and Lyle the patient's vital capacity was 54 per cent of normal. After the diagnosis was established the patient was allowed to go untreated for seven weeks at which time he still complained of pain in the left chest, dyspnea, and had a vital capacity of 47 per cent.

Pneumothorax therapy was then begun in an attempt to correct the mediastinal shift. The initial inspiratory pressure was 38 cm. of water. The patient was considerably relieved by his pneumothorax which then had to be abandoned because he developed a hydrothorax.

Approximately two months later, the patient was again admitted with dyspnea and chest pain. Roentgen examination of the chest revealed no residual air or fluid in the left hemithorax. The initial inspiratory and expiratory pressures were minus 58 and minus 44 cm. of water respectively. Therapeutic pneumothorax was again instituted with considerable relief. After several fillings the patient was much improved and the air injections were discontinued.

When last examined, about fourteen months after his injury, the patient was comfortable. His pressure reading in the left pleural cavity was minus 8 cm. of water; in the healthy right chest, minus 6 cm. of water.

The most recent report on this subject was published in October, 1947, by Kinsella and Johnsrud,[6] who added 2 more records to the literature.

Their first patient was injured by the wheel of a farm truck; complaining of dyspnea, cough and expectoration, he was first seen by the authors twenty-eight months after his injury. Roentgenograms of his chest revealed complete occlusion of the right stem bronchus. A total pneumonectomy was performed which revealed not only the occluded main stem bronchus but an old rupture of the right upper lobe bronchus which was also healed and obstructed.

Their second patient, a boy, aged seven, was crushed between a truck and a brick wall. He was hospitalized immediately, at which time cyanosis, dyspnea, and marked interstitial emphysema were observed. He was examined bronchoscopically the second day, when a tear about 5 or 10 mm. long was identified in the right main bronchus near the carina. Two weeks later the boy was again examined by the bronchologist, who found no evidence of stenosis but did remove a large clot from the affected stem bronchus. The child left the hospital apparently well.

Twenty-four days after the original injury and eight days after his last bronchoscopy, the child was readmitted because of a severe cough and cyanosis. Roentgenograms of his chest revealed marked collapse of the right lung. When examined bronchoscopically, his right stem bronchus was almost completely closed.

The boy adapted himself very well to his bronchial occlusion and suffered no apparent real physical handicap.

DISCUSSION

At least 32 patients with bronchial tears have been recorded in the literature since 1889. Of these, 10 survived the immediate affects of their injury and developed bronchial occlusion. Seventeen had tears in the left main bronchus, 13 had tears in the right, and in 2, both bronchi were torn. In every instance, the bronchial defect lay immediately adjacent to or within a few centimeters of the bifurcation of the trachea.

With but 2 exceptions[13,17] the injuries were due to violent impacts with vehicles. Whereas fractured ribs were the rule, there were some individuals whose ribs were intact. Indeed, a few, including the patients recorded by May and Bowen[9] and Bradford,[2] suffered no thoracic cage damage. The torn bronchus almost always lay in the injured half of the thoracic cage to which the major force of the blow was delivered at the time of the accident.

Schonberg[15] attributed the bronchial tears to two factors. He felt that most tears were due to compression of the bronchus between the elastic chest wall and the rigid spine. He also believed that there existed abnormally high air pressures within the bronchus at the time of the impact which caused it to rupture.

Bronchial compression alone would not explain the rupture because there were many patients without severely damaged chest walls. The increased air pressure in the tracheobronchial tree seemed the more plausible explanation.

Usually, when a victim tries to protect himself from an onrushing blow, he "tightens up" and becomes rigid. This strain makes him stop breathing and hold his breath, inadvertently closing off his larynx and trachea. In this manner, the normally open tracheobronchial tree is converted into a closed air-filled system.

When the air pressure in such a closed system is raised gradually by an external force, the increased air tension that results is distributed equally throughout. When the external force is applied suddenly, however, the increased air pressure is greatest near the point of impact. When one remembers that the torn bronchus almost always lay in the injured half of the thoracic cage, it seems reasonable to attribute the tear to the latter mechanism. This would also explain the explosive onset of interstitial emphysema described in a few patients for the air causing the bronchial "blow out" would of necessity enter the interstitial tissues.

Finally, attention is called to the fact that in one individual[16] the torn bronchus was proved to be due to a fractured rib which pierced it.

The most common clinical finding was dyspnea. It was usually severe and disabling, but a few patients were not too distressed. Cyanosis occurred regularly, particularly in the severely dyspneic. A superficial cough was described in some which was often blood tinged or attended by frank hemoptysis.

About two-thirds of the victims revealed interstitial emphysema. Sometimes, it progressed rapidly over the face, abdomen, and arms assuming grotesque proportions. Its sudden appearance immediately after injury[4,10] suggested that the air was squeezed out of the lung, through the "blown out" bronchus into the soft tissues.

The classical signs and symptoms of shock were found regularly. In rare instances hemorrhage complicated the picture.

The physical examination varied remarkably depending upon the severity of the torn bronchus and the amount of air entering the thoracic cavity and interstitial tissues. Limited thoracic expansion (unilateral or bilateral), rapid shallow respiration, mediastinal shift, positive pressure pneumothorax, subcutaneous crepitation and fractured ribs were common. Anoxia and shock were the immediate threats to life. In some patients collapse occurred precipitously because of which constant vigilance was mandatory. In a few patients heroic methods had to be used to release collections of air that caused sudden shifts in the mediastinum.

The patients who died usually succumbed within the first twenty-four hours. A few lasted longer, one individual dying at the end of fifty-five hours.[5]

It is obvious that there must be some individuals with torn bronchi who have made complete recoveries from their injury. They would never have been recorded in the literature. Those who recovered from the immediate effects of their injuries and were reported in the literature all developed bronchial occlusion with complete pulmonary collapse. In some, it was recognized within days or weeks, in others months, and in a few it remained unrecognized for twenty to thirty years.[14]

The subjective symptoms in the patients who lived and developed post-traumatic bronchial occlusion varied. In rare instances there were absolutely no complaints, the findings being accidental[3,7,14] More commonly these individuals complained of vague substernal oppression. In some, it was actually painful. Dyspnea, mild or severe, was the rule in many.

It was noteworthy how often therapeutic pneumothorax relieved the symptoms. This was particularly noticeable in patients with abnormally high negative intrathoracic pressures in the affected hemithorax.[18]

Four patients had their collapsed lungs removed. Rienhoff[14] reported two, Kinsella and Johnsrud[6] one, and our patient was the fourth. All were much improved by their pneumonectomy.

The roentgen manifestations of bronchial tears varied depending upon when the patient was first examined. The chest ex-

amined soon after injury, while the rupture was still open, usually revealed interstitial emphysema, pneumothorax, pulmonary collapse, mediastinal shifts and fractured ribs. The interstitial emphysema commonly started in the mediastinum and then spread along facial planes to the homolateral supraclavicular fossa, neck, and chest wall. Sometimes it started on the chest wall at the same time, particularly when the pleural cavity was pierced by fractured ribs.

Pneumothorax was unilateral or bilateral. Whereas it was most common on the side of the bronchial tear, the rare patient presented more air in the contralateral hemithorax.

The position of the mediastinal structures also varied remarkably. As a rule, the mediastinum shifted away from the side of the greatest increased intrapleural pressure. As the air tension changed, its position changed. Occasionally the shift occurred suddenly and caused death. When positive pressure collections of air were absorbed or released, the mediastinum shifted back to its more normal midline position. Finally, when the lung collapsed, the mediastinum shifted toward the affected hemithorax.

Roentgenographically, traumatic bronchial occlusion was characterized by complete collapse of the homolateral lung and marked changes in the alignment of the mediastinum. Compensatory variations in the bones of the thoracic cage, as well as alterations in diaphragmatic levels were the rule. In rare instances, particularly when the bronchial tear and occlusion occurred early in childhood, the compensatory emphysema that developed in the normal lung was marked enough to herniate through the mediastinum into the side of the occluded bronchus, thereby revealing roentgen evidence of aerated lung tissue in the injured half of the thoracic cage.[14] When this developed, the collapsed atrophic lung occupied but a small portion of the homolateral hemithorax.

Bronchography always revealed complete bronchial occlusion. The lipiodol always entered a blind pouch close to the carina which was smooth in outline and cup shaped. Filling defects lining the bronchial walls were not seen in any of the patients recorded in the literature or in ours. Body section roentgenograms of the affected bronchus, although less brilliant than the lipiodol or pantopaque studies, were equally characteristic and diagnostic. They too revealed a blind pouch and perfectly smooth bronchial walls.

Of considerable interest was the fact that these collapsed lungs never became infected. Whereas pulmonary collapse is usually associated with pulmonary infection, there was not one patient in the literature in whom this was described either clinically or histopathologically. The fact that these were "complete" bronchial obstructions which prevented organisms and infected debris from entering the collapsed lung must have been the cause. A patient reported by Krinitzki[7] demonstrated this beautifully.

Krinitzki's patient died as the result of extensive pulmonary tuberculosis. At autopsy the entire right lung was riddled with tuberculosis, while the left lung, which was completely collapsed, was free of tuberculosis. Dissection of the latter revealed an occluded main bronchus. The patient's past history indicated that she had suffered a severe chest injury with a torn bronchus and bronchial occlusion seven years before she developed pulmonary tuberculosis. Thus, because her bronchus was entirely occluded, tubercle bacilli were denied entrance into the collapsed lung which remained uninvolved.

At autopsy, section of these atelectatic lungs often revealed the bronchial tree filled with jelly-like mucus.[14] This was found at operation and confirmed histopathologically in our patient (Fig. 4).

No one has treated enough patients with torn bronchi or traumatic bronchial occlusion to write authoritatively concerning treatment. The basic therapeutic principles involved, however, seem fairly well established.

When the patient has just been injured all efforts must be directed toward the

control of shock and hemorrhage. At the same time, one must maintain careful vigilance to prevent tension pneumothorax from developing if sudden deaths are to be avoided. The insertion of a catheter into the pleural cavity by an interrib trocar with constant suction of about 10 cm. of water may prove life saving, particularly when rapid reaccumulations of intrathoracic air cannot be controlled by repeated simple aspirations.

Once the acute phase of the injury has been survived, one is faced with the problem of preventing bronchial occlusion.

The histories of many patients with traumatic bronchial occlusion reveal that there usually exists a period of days or weeks between the date of the injury and the time when bronchial occlusion develops when the lumen of the torn bronchus must be open. Unless this were true, one could not explain the complete reexpansion of previously collapsed lungs observed roentgenographically. It seems reasonable, therefore, to postulate that had the bronchial tears been recognized early, the occlusions might have been prevented by successive bronchial dilatations and bronchoscopic aspirations. Whereas such instrumentation would not have been without hazard, so much would have been gained if successful that we plan to try it if afforded the opportunity in the future. Actually, if operated upon early, it would seem theoretically possible to close these bronchial tears surgically.

The therapeutic problems are different after the bronchi become occluded and the lungs atelectatic. In such instances cough, substernal oppression and dyspnea commonly develop due to mediastinal distortions and compensatory pulmonary emphysema.

Therapeutic pneumothorax has been helpful occasionally in these patients. This has been particularly true in patients with abnormally high negative intrapleural pressures. At least 4 patients[6,14] have undergone total pneumonectomy with marked improvement. Whereas thoracoplasty has not been employed, it may prove to be the treatment of choice when an unqualified diagnosis of traumatic bronchial occlusion can be established. Not only would it partially correct the deviated mediastinum and hyperventilated residual lung, but it would prevent blood from passing through the collapsed lung to the peripheral circulation as unoxygenated blood, thereby relieving dyspnea. Kinsella and Johnsrud[6] suggested that, among other modalities, oleothorax or cutting of the corresponding phrenic nerve might be worth considering.

CONCLUSIONS

1. Severe chest injuries may cause tears in the main stem bronchi at or close to the bifurcation of the trachea.

2. When this occurs, the patient usually reveals shock, dyspnea, anoxia, interstitial emphysema, and cough.

3. Whereas such accidents may cause death, patients have survived the immediate effects of their injury to develop post-traumatic bronchial occlusion with pulmonary collapse.

4. Routine roentgenograms of the chest immediately after injury may reveal fractured ribs, interstitial emphysema, pneumothorax, pulmonary compression, and mediastinal shift.

5. Later, when bronchial occlusion is complete, the classical roentgen manifestations of pulmonary collapse develop.

6. Bronchograms reveal a cup-shaped blind pouch at the site of the occlusion.

7. Substernal distress and dyspnea occur commonly in patients with post-traumatic bronchial occlusion.

We wish to thank Dr. Gabriel Tucker for allowing us to study and report this patient. We are also indebted to Dr. John Harris whose original roentgenograms were made available to us. Appreciation is also due Dr. Robert C. Horn whose pathological interpretations helped complete this report. Dr. Louis H. Clerf and Drs. M. D. Tyson and J. S. Lyle allowed us to use illustrations from their original manuscripts on this subject. We are indebted to them for this privilege.

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PULMONARY EMBOLISM WITHOUT INFARCTION*

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AS a result of numerous well correlated clinico-pathological studies, pulmonary embolism is now known to be a common complication of many diseases and operations. Thus, Hampton and Castleman[4] reported pulmonary embolism or infarction in 9 per cent of 3,500 autopsies, while Möller[6] found pulmonary emboli in 28 per cent of 176 routine postmortem examinations. Carlotti and his associates[1] report an even greater incidence of pulmonary embolism in medical than in surgical patients, the average yearly percentage being 0.6 per cent. The increasing frequency of diagnosis is probably due to better diagnostic criteria and greater attention to this particular condition. Although emboli involving the larger pulmonary arteries usually produce characteristic symptoms and signs (chest pain, hemoptysis, cough, dyspnea, friction rub) emboli lodging in smaller pulmonary arteries may have few or no symptoms. It is not at all unusual to find emboli of the latter type at necropsy when they are entirely unsuspected clinically.

Pulmonary embolism, however, does not always result in the formation of a hemorrhagic infarct. Adequate clinical and experimental data support the thesis that embolism to a lung in an individual with a normal circulation does not ordinarily produce infarction. On the other hand, infarction is rather frequent in cardiac decompensation and particularly in severe mitral valvular disease. This apparent paradox is explained by the dual circulation to the lungs through the bronchial and pulmonary vessels. The former are concerned with the nutrition of the lungs while the latter are actively engaged in the respiratory exchange of gases. Guillot,[3] Miller,[5] and others, have clearly demonstrated communications between the bronchial artery and pulmonary veins. There are also abundant anastomoses between the bronchial and pulmonary capillaries. These collateral channels are so extensive that complete occlusion of one or even both pulmonary arteries may not result in infarction. It is significant that Carlotti and his associates,[1] in reporting on their large series of cases of pulmonary embolism, are careful to distinguish sharply between pulmonary embolism and pulmonary infarction, indicating their recognition that the two are not necessarily synonymous. In considering the roentgenologic findings in their cases, however, they deal entirely with pulmonary infarction and give no impression that there are any roentgenologic findings in pulmonary embolism without infarction. They do indicate that a small percentage of their cases of pulmonary embolism exhibited apparently normal lung fields in the roentgenogram.

That embolism or thrombosis of the major pulmonary arteries do not usually result in infarction is well known. In many cases death ensues so rapidly after embolism of the artery supplying a whole lung that there is no time for infarction to occur. There are other cases, however, in which occlusion of a major pulmonary artery has occurred with survival of the patient and with no evidences of infarction. Such a situation is illustrated by the following case recently observed:

A man, aged thirty-seven, with an Eisenmenger's complex was examined. Roentgenoscopic and roentgen kymographic studies demonstrated a marked enlargement of the major pulmonary arteries with a complete absence of pulsation in the right pulmonary artery. The shadow of the vessel was enlarged and much more sharply defined than normal. The radiability of the right lung field may well have been slightly increased above the normal although

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this was so minor as to be difficult to establish (Fig. 1). At autopsy, in addition to the congenital defects in the heart (Eisenmenger's complex), there was found a complete occlusion of the right pulmonary artery by an old organized thrombus. Marked atherosclerotic changes of all the pulmonary arteries were present. Nevertheless there was no evidence of infarction whatever in the lungs, the appearance corresponding well to the roentgenographic findings shown in Figure 1.

A somewhat similar case with almost complete thrombosis of both main pulmonary arteries, without infarction, is reported in the literature.[2]

Following prolonged roentgenologic studies, with postmortem controls, Westermark[7,8] concluded that hemorrhagic infarction does not occur unless there is an occlusion of both the bronchial and pulmonary arteries. If only the pulmonary artery is obstructed, infarction does not follow and the involved pulmonary segment remains viable even though it may be unable to carry on any exchange of gases. In the case of septic emboli, spread of the infection to the contiguous pulmonary vein and bronchial artery readily takes place and hemorrhagic infarction results. He found that only 20 per cent of the cases in which pulmonary embolism was established at autopsy showed evidences of infarction.

In spite of these investigations most roentgenologists still associate pulmonary embolism with an area of increased density in the roentgenogram. In 1938 Westermark[7] described the roentgen appearance of pulmonary embolism without infarction. In a review of the literature at that time he was able to find only one previous similar report by von Dehn. Because the importance of these observations has not been generally appreciated, as illustrated by the recent review of Carlotti and his associates[1] noted above, we wish to direct attention to Westermark's observations and to emphasize the frequency of pulmonary embolism without infarction. To do so, we are reviewing the roentgen signs and presenting 3 illustrative cases observed during the past year and confirmed at autopsy.

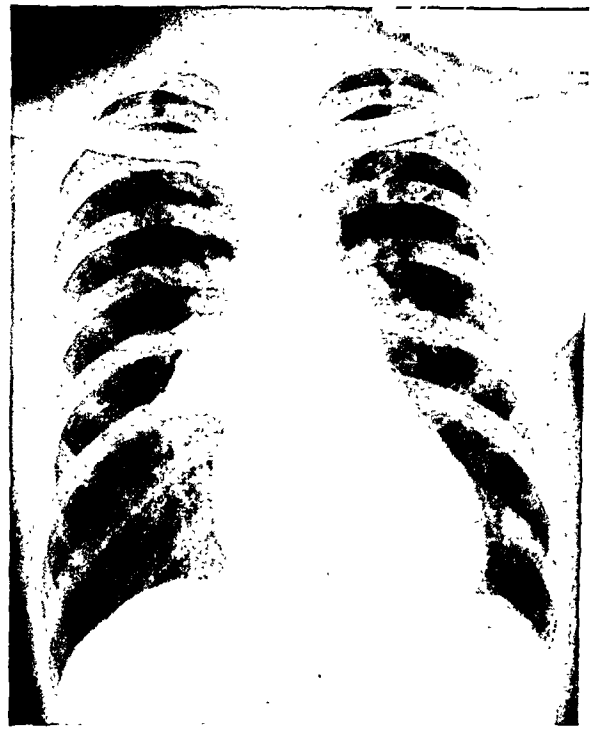


FIG. 1. Posteroanterior roentgenogram showing markedly enlarged, thrombosed right pulmonary artery in a patient with an Eisenmenger's complex. Note the normal appearance of the lung fields, the right being possibly slightly more radiable than the left. The absence of any evidence of infarction in a case with complete occlusion of the right pulmonary artery of long standing is illustrated here.

ROENTGEN FINDINGS

In pulmonary embolism without infarction the characteristic finding is ischemia of the involved pulmonary segment. This is represented by a segmental area of increased radiability on the chest roentgenogram. Central to the site of the embolism the vascular pattern is well outlined, while in the area itself the vascular pattern stops rather abruptly. In addition, there is often increased density and sharper demarcation of the involved vessel. The local area with diminished or absent vascularization corresponds to the pulmonary segment supplied by the embolic artery. As Hampton and Castleman[4] so ably demonstrated, the shape of an infarct is determined princi-

pally by the configuration of the involved pulmonary segment. This is likewise true of the area of ischemia due to embolism without infarction. Thus, in the case of an embolus to a pulmonary artery supplying a pulmonary segment, lobe or a whole lung, the segment, lobe or entire lung is anemic, as the case may be. The increased radiability is particularly striking when it occurs alongside an area of hemorrhagic infarction, since both processes may be found in the same lung or opposite lungs. These findings are in striking contradistinction to the usual area of increased density on the roentgenogram in cases of pulmonary embolus with infarction. The embolus without infarction may undergo organization and recanalization or it may be absorbed, thus leading to the reestablishment of the circulation in the affected pulmonary artery. If either of these two processes takes place, the area of increased radiability is replaced by a zone of normal density and vascularization. On the other hand, retrograde thrombosis may occur producing involvement of a larger area of pulmonary tissue.

The area of increased radiability due to pulmonary embolism without infarction must be differentiated from partial bronchostenosis with obstructive emphysema and also from localized areas of non-obstructive emphysema. In obstructive emphysema, the changes during expiration with the shift of the mediastinum toward the normal side and the depression of the involved diaphragm serve to differentiate these two conditions. Localized areas of non-obstructive emphysema may be somewhat more difficult to distinguish. However, the abrupt termination of the vascular pattern at the site of the embolus is usually sufficient to make the diagnosis.

CASE REPORTS

Case 1. A.K., a housewife, aged fifty-seven, was admitted to the University Hospital on April 26, 1947, complaining of abdominal discomfort of approximately ten years' duration. A cholecystectomy had been performed in 1938. In January, 1946, she became jaundiced and experienced several attacks of severe upper abdominal pain associated with nausea, vomiting and clay-colored stools. Four weeks prior to admission she was operated upon at another hospital at which time a T-tube was placed in the common duct without relieving the jaundice. On admission, the physical and laboratory findings were consistent with a diagnosis of obstructive jaundice.

On April 26, 1947, a chest roentgenogram showed normal lung fields with considerable elevation of the right diaphragm (Fig. 2). At 4:00 P.M. on April 19, 1944, the patient suddenly

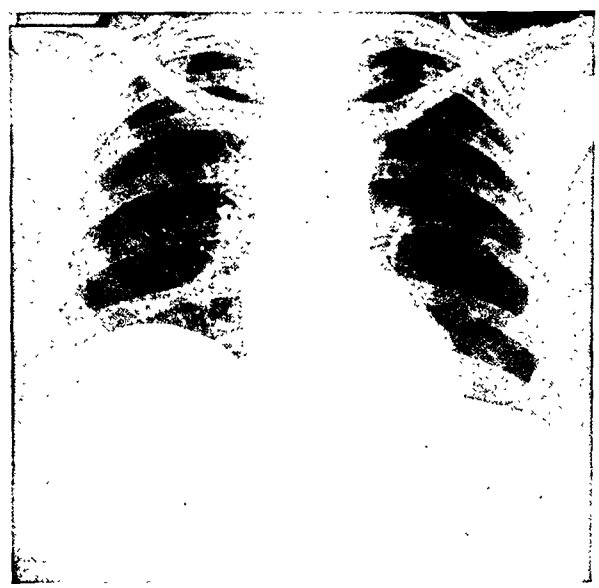


Fig. 2. Case 1. Posteroanterior roentgenogram of the chest made on admission. The lung fields appear normal. The right diaphragm was slightly elevated.

became markedly dyspneic At 9:00 P.M. she experienced severe pain in the right chest. Physical examination revealed a temperature of 102°F., pulse rate of 125 per minute, and some moist rales at both bases. A medical consultant at this time suggested the diagnosis of congestive heart failure and recommended digitalization. The roentgenogram of the chest was repeated and showed marked elevation of the right diaphragm with a sharply defined area of increased radiability and ischemia in the right lower lobe (Fig. 3). A diagnosis of embolism without infarction was ventured by the roentgenologist.

On April 30, 1947, tenderness along both calf

veins and the left femoral vein was noted. The patient also had a mild episode of hemoptysis. Two electrocardiograms were negative. Penicillin and heparin were instituted and the patient was digitalized. On May 3, 1947, she began to bleed from the mouth and nose and the heparin dosage was reduced. She then seemed to improve slightly, even though the jaundice increased in severity. From May 17, 1947 on, her condition steadily deteriorated and she died on May 21, 1947.

The important findings at necropsy were confined to the pancreas, biliary tract, heart and lungs. A small calcified cyst was present in the

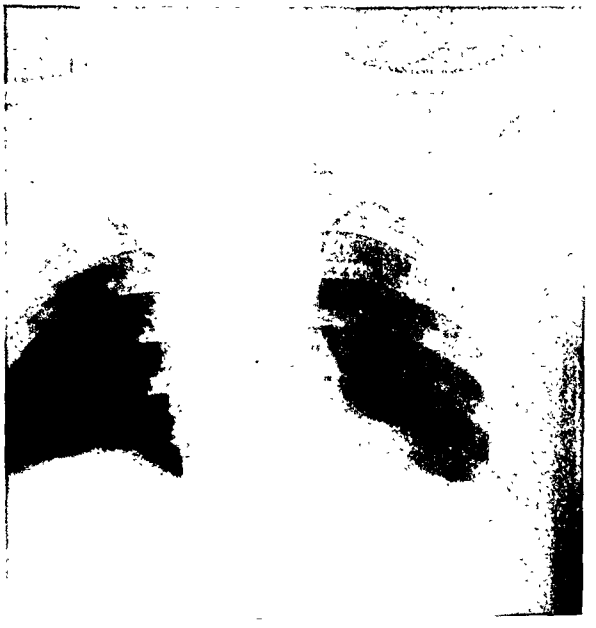


Fig. 3. Case 1. Anteroposterior roentgenogram made six and a half hours after the onset of symptoms of pulmonary embolism. A segmental area of increased radiability in the right lower lobe is shown. Note the relative absence of vascular pattern and the sharp termination of the pulmonary artery shadow. The changes are readily recognized in contrast with the findings seen in the film made before the onset of the embolus (Fig. 2).

body of the pancreas. The right and left hepatic ducts, as well as the distal end of the common duct, were obstructed by scar tissue. The mitral valve was thickened and had a few soft vegetations along its free border. The left pleural cavity was obliterated by adhesions, while the right contained 200 cc. of blood. An embolus was found in the pulmonary artery supplying the right lower lobe but no infarction was present (Fig. 4). Pulmonary edema of the left



Fig. 4. Case 1. Postmortem photograph of the right lung. The arrows point to the pulmonary artery of the right lower lobe which contained the embolus.

lung and the right upper and middle lobes was also noted.

Case II. E.T., a white female aged seventy-one, was admitted to the University Hospital on December 2, 1946, with complaints of abdominal pain and vomiting of six weeks' duration. Prior to this time there had been episodes of nervousness, exertional dyspnea, headache and dizziness. There was a long history of right upper quadrant pain, nausea and vomiting. On admission, a vague, slightly tender midline epigastric mass was palpable.

On December 3, 1946, a gastrointestinal series revealed a considerable degree of pyloric obstruction. A barium enema on December 16, 1946, demonstrated abnormal separation between the greater curvature of the stomach and the transverse colon with a pronounced indentation of the superior surface of the transverse colon near the splenic flexure. The clinical impression was carcinoma of the head of the pancreas with secondary infiltration of the stomach and colon.

An exploratory laparotomy was performed on



Fig. 5. Case II. Anteroposterior view of the chest made on the day of operation demonstrating some congestion of the left lung field and a relatively normal right lung. The right diaphragm is slightly elevated. The air under the right diaphragm was due to the abdominal surgery.

December 19, 1946, and a carcinoma of the gallbladder was found with peritoneal carcinomatosis. A gastroenterostomy and catheter choledochostomy for drainage of the common duct were done. Postoperatively the patient's temperature rose to 103.6° F., with a pulse rate of 110/120 and respirations of 36. A chest roentgenogram at this time showed only some elevation of the right diaphragm with residual air under the diaphragm from the previous surgery (Fig. 5). On December 20, 1946, the patient complained of a slight cough and abdominal pain. The chest roentgenogram (Fig. 6) was repeated on December 21, 1946, demonstrating marked elevation of the right diaphragm. The heart was slightly displaced to the left and patchy areas of consolidation were present in the left lung. In the right lung there was abrupt termination of the vascular shadows to the lower lobe with increased radiability in this area. The possibility of an embolus without infarction was then suggested.

The patient received parenteral fluids, digitoxin, aminophyllin and mercupurin, but in spite of this therapy a persistent oliguria developed and she died on December 25, 1946.

At necropsy, a large bile stained abscess was present under the right diaphragm. There was obvious leakage around the catheter in the common duct with small collections of bile in the right quadrant and the right lateral gutter. The gallbladder was the seat of a carcinoma. It contained four stones and was bound down by many adhesions. The common duct was surrounded but not obstructed by the carcinomatous process which extended around the proximal duodenum. Although the liver appeared to be grossly normal, microscopic study showed some metastases. There was also diffuse peritoneal carcinomatosis.

The heart was slightly enlarged. There was some left ventricular hypertrophy, calcification of the aortic leaflets and atherosclerosis of the aorta.

The right pleural cavity contained 150 cc. of cloudy sanguineous fluid while the left pleural cavity was partially obliterated by adhesions. There was atelectasis of much of the right middle lobe and right lower lobe with petechial hemorrhages on the surface of these lobes. Near the hilum of the right lung at the bifurcation of the pulmonary arterial branches to the



Fig. 6. Case II. Anteroposterior view of the chest made thirty-six hours later, after the development of pulmonary symptoms. Note the marked elevation of the right diaphragm. There is considerable radiolucency and ischemia of the right lower lobe. Note also the densities in the left lower lobe which were due to congestion and bronchopneumonia. A pulmonary embolus without infarction on the right side was found at autopsy.

middle and lower lobes, there was a rider embolus without infarction. The left lung was somewhat congested and the bronchi exuded a cloudy, somewhat purulent fluid on compression.

Case III. The third patient seen, after operation, had a few symptoms to suggest pulmonary embolism. On roentgen examination there were evidences of increased radiability in the right lower lobe especially as compared to the remaining lung fields. On the left side there were two small areas of increased density in the lower lobe. The diagnosis of pulmonary embolism without infarction on the right side and possible pulmonary emboli with infarction on the left was made antemortem. These findings were confirmed at autopsy, an embolus to the pulmonary artery supplying the right lower lobe being present without any lung infarction. There were two emboli in the left lower lobe with hemorrhagic infarcts in the appropriate segments. Owing to the fact that the films were made at the bedside under unfavorable conditions they are not suitable for reproduction.

DISCUSSION

In all 3 cases there were symptoms suggestive of embolism but the physical signs were not evident. While the roentgen findings are not unusually striking the changes in the appearance of the lung from that found on roentgenograms made before the onset of the acute process were sufficient to give credence to the observation of increased radiability and abrupt termination of the vascular pattern. The findings noted above were fully confirmed at autopsy. Other cases of similar character have been observed but are not reported since the patients survived and autopsy confirmation could, therefore, not be obtained.

SUMMARY

1. Pulmonary embolism may occur without infarction owing to the double circulation of the lungs.

2. In pulmonary embolism without infarction the characteristic roentgen findings are increased radiability and ischemia of the involved pulmonary segment. Abrupt termination of the embolic pulmonary artery is also frequently demonstrable. This contrasts strikingly with the usual area of increased density on the roentgenogram found in cases of embolism with infarction.

3. The differential diagnosis of embolism without infarction is discussed.

4. Three cases of pulmonary embolism without infarction, confirmed at autopsy, are presented.

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BENIGN PEDUNCULATED TUMORS OF THE ESOPHAGUS

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PEDUNCULATED tumors of the esophagus are of special roentgenological interest because they present definite shadows that may be overlooked or misinterpreted when the patient's history and physical examination do not suggest this type of lesion.

Fahr[4] reported a case which had both roentgenologic and esophagoscopic examinations yet the true diagnosis was not made until autopsy was done. Postmortem examinations have first revealed the tumor in many of the reported cases and in most instances of discovery at autopsy there was no history of symptoms referable to the esophagus. Davison's[2] case had no symptoms and he discovered the large pedunculated tumor when it extruded from the mouth with vomiting during a temporary gastrointestinal upset. Thus pedunculated tumors of the esophagus may be encountered in a routine examination of the gastrointestinal tract. Some of the mistaken diagnoses made from roentgenological examinations were substernal thyroid, cardiospasm with dilated esophagus, and extraesophageal mediastinal tumor.

Long before the discovery and diagnostic use of the roentgen ray several textbooks of pathology stated that polypi of the esophagus may occur with long pedicles. Probably the first detailed case report of benign pedunculated esophageal tumor was made by Monro[9] in 1763. He gave a complete account of the history, physical findings, and treatment. Since 1763 several similar cases have been reported.

Vinson[16] reported the first case in the American literature. Recently Samson and Zelman[13] reviewed the literature to find 25 cases besides their own of pedunculated esophageal tumors having a length of 7 cm. or more. Tamiya and Nosaki[15] in 1926 claimed to be the first to make a correct diagnosis from the roentgenological findings. Patterson[12] credits Sommer[14] with being first to make the diagnosis by means of roentgen studies.

In the case to be reported an esophageal tumor was considered prior to roentgenological examination because the patient gave a history of having regurgitated a fleshy mass, then swallowing it when he found it to be firmly attached somewhere in his throat.

Three of the cases reported by Moersch and Harrington[8] had regurgitated their pedunculated tumors and in each case the patient had attempted to bite it off. In each of the 3 cases surgical removal was successful.

A more recent study of benign esophageal tumors of all types by Adams and Hoover[1] obtained reports on 147 cases. They added 3 case reports in 1 of which the patient could regurgitate the tumor.

We report our case as follows:

CASE REPORT

S.R., male, aged seventy, complained of nocturnal attacks of choking and suffocation. He also had a constant feeling of fullness in the neck and upper mediastinum. Symptoms were first noted twelve years ago and had gradually increased. Two years ago distress became so severe that he would be wakened frequently by choking and suffocation. Six months ago he raised a smooth tumor mass from the throat during a severe attack of choking. The mass protruded beyond the mouth and when it was in this position did not afford obstruction to breathing (Fig. 1). An unsuccessful attempt was made to bite off the tumor. Within a few seconds the mass was swallowed without difficulty. A few weeks later a similar episode occurred and the patient noted, by use of a mirror, that the tumor was a two-pronged, fleshy mass. He found that sleeping at about 40 degrees

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elevation of the head and shoulders would prevent the choking and suffocation. There was no remarkable swallowing difficulty at any time.

Physical Examination. General physical examination failed to reveal anatomical abnormality or evidence of disease. The patient was well nourished and appeared to be in good health. Examination of the nose and throat by direct and indirect methods was negative. During the examination of the throat the patient's gag reflex was activated and caused regurgitation of the tumor so that part of it could be examined.

Roentgen Examination. On March 11, 1942, the patient was referred by Dr. Wm. F. Molt for roentgen examination. The esophagus was examined, using barium mixture, and a large filling defect was found extending from the level of the seventh cervical vertebra down to the sixth dorsal vertebra (Fig. 2). The outline of the tumor shadow was smooth and there was no obstruction to the passage of barium. Irregularities at the upper limit of the shadow appeared to be due to the attachment of the pedicle though the exact anatomical location of attachment was not clear. The trachea was displaced anteriorly about $\frac{3}{4}$ inch from the level of the manubrium down to the carina and there was no evidence of lung, heart, or aortic disease.

Impression. Benign pedunculated esophageal tumor.

Operation. The tumor was removed by Dr. Wm. F. Molt on March 16, 1942. He gives the following description of the procedure: "Under general anesthesia a suspension apparatus with a specially constructed long spatula was used to expose the mouth of the esophagus. With the suspension apparatus adjusted and using head-projected illumination both hands of the operator were free. The cricoid cartilage was lifted with the rubber covered distal end of the spatula to expose the mouth of the esophagus. This method revealed the base of the mass which was just inside the esophageal orifice. By direct vision a special clamp was applied at the tumor attachment and the pedicle was ligated with No. 10 silk ligature. The pedicle was then severed above the clamp. The tumor measured 1 inch in diameter and $8\frac{1}{2}$ inches in length."



Fig. 1. Showing the tumor as it protruded from the mouth without affording obstruction to breathing.

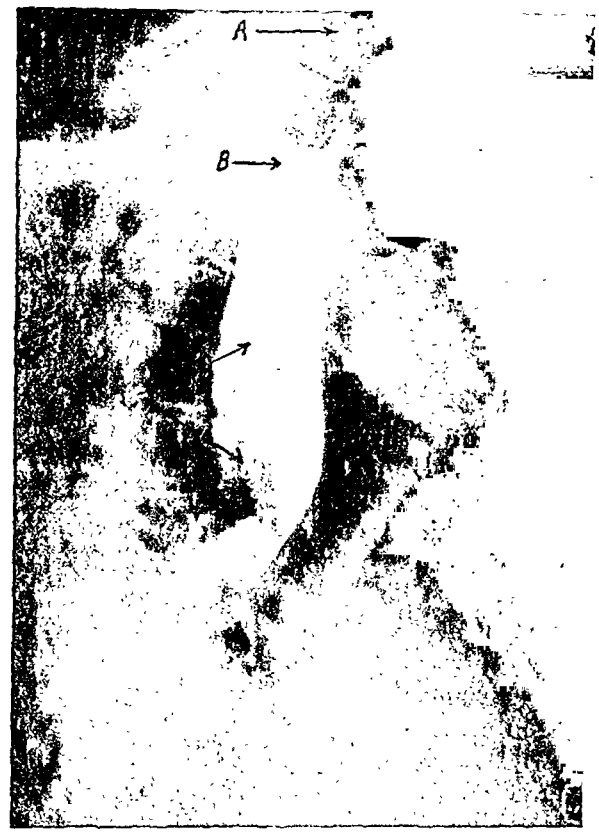


Fig. 2. *A*, site of pedicle attachment found at time of removal. *B*, level of attachment indicated from the preoperative roentgen study. *C*, translucent areas caused by the filling defect.

The patient made an uneventful recovery and left the hospital on the fourth day. There was no hemorrhage and all of his symptoms were relieved.

Note: The attachment of the pedicle was higher than anticipated from the roentgeno-

logical study. The slender pedicle extended from the level of the fourth cervical vertebra to the seventh which was the upper level of the observed filling defect.

Gross and Histopathological Examinations. The gross specimen consists of an elongated bifurcate tumor mass having an over-all length of 12.5 cm. The diameter of the main body is 4.5 cm. and the diameter of the bifurcations is approximately 2 cm. The mucous membrane surface is smooth except for small granulations on one of the secondary projections. The entire tumor is soft and elastic.

Section for microscopic study taken through various levels of the tumor mass removed from the esophagus show a fibrolipomatous structure which is covered by a dwarfed atrophic layer of squamous epithelium. Papillary pegs of squamous epithelium are absent and the basement membrane sharply delineated. The underlying tissue is composed of strands of dense fibrous connective tissue in various degrees of hyalin degeneration, permeating the structure in wild and irregular disorder. The stroma also shows patchy accumulations of fatty tissue surrounding or infiltrating the fibrous tissue. An occasional zone of myxomatous tissue can be identified. In all this arcuate pattern there is a massive edema. Small round cell infiltration is diffusely disseminated throughout the central core of connective tissue, and is present in a zone-like margin just beneath the squamous cell lining. In a few areas the epithelium becomes keratinized and piles itself into tiny microscopic projections which are all quite regular in cellular content without neoplastic deviation.

Impression. Polypus of the esophagus with low grade inflammatory process, benign.

Out-Patient Progress. Four years after removal of the tumor the patient was free of symptoms and in excellent general health.

GENERAL DISCUSSION

Pedunculated tumors arising at the upper end of the esophagus are nearly always single, whereas multiple pedunculated tumors may be found in the middle and distal thirds.

It is remarkable that a majority of the single pedunculated tumors arise in the region where esophageal diverticula commonly have their origin. The esophagus at this level is narrowed and the mucosa is redundant due to the high degree of mobility necessary for swallowing.

Once a benign tumor forms in the esophageal wall in this region or a fold of redundant mucosa sags sufficiently, the peristaltic action with traction of the passing food tends to gradually drag it downward.

The peristaltic traction may also produce the bifid structure at the distal end. Garretson and Hardie[6] believe peristaltic action caused the bifid distal end of the tumor found in their case.

Symptoms. The tumor may reach a very large size without causing esophageal obstruction. Pape and Spitznagel[11] reported a case of very large tumor without history of difficulty in swallowing. The chief complaint was dyspnea and substernal thyroid was thought to be present.

As the tumor elongates and approaches the cardia, obstruction develops.

Pain is not present unless there is ulceration of the tumor or the adjacent esophageal wall.

Fahr reported a case which was examined roentgenologically and findings compared with those at postmortem. The roentgenological findings in his case were esophageal dilatation and cardiospasm. Esophagoscopy did not visualize the tumor which was thought to be extrinsic to the esophagus. The patient died of starvation and Fahr stated that the patient could probably have been saved had the diagnosis been made.

Cardiospasm is not uncommonly associated with the very long tumors. Haenisch[7] reported a case which showed mediastinal widening, esophageal filling defect and cardiospasm. The diagnosis was cardiospasm.

Tracheal compression is present in most cases having large tumors. Dyspnea may be present without dysphagia. Pape and Spitznagel's case, previously referred to, had a very large globular tumor which was diagnosed as substernal thyroid and operated on. The tumor was not found and the patient died several weeks postoperatively.

Diagnosis. When mediastinal widening is seen in the chest roentgenogram and symptoms referable to the esophagus have been present over a long period of time, benign tumor should be considered. Since the smaller tumors may be silent, routine gastrointestinal examinations revealing slight abnormality in the passage of barium through the esophagus, such as splitting of the stream or uneven distribution, should lead to a detailed examination.

Due to the usual irregularity at the distal portion of the tumors and associated uneven pressure on the various areas of the tumor by the esophageal wall, the shadow produced by the mass will be remarkably uneven as outlined against the esophageal wall. The mottled appearance is partly due to pressure afforded by extra-esophageal mediastinal structures causing the barium stream to be thin, whereas it will be heavy over areas not adjacent to firm structures.

The area of attachment may be identified by remarkable irregularity in the esophageal wall just above the pedicle shadow. Esophageal peristalsis and elasticity are maintained around the filling defect.

Double contrast examination as described by Palugyay[10] may be helpful in establishing a diagnosis with difficult cases. This is simply done by having the patient take barium then swallow air.

Feldman[5] reported an adenocarcinomatous pedunculated polyp and states that the diagnosis of malignant degeneration in a polyp cannot be made.

DIFFERENTIAL DIAGNOSIS

The following conditions are to be considered: carcinoma, extra-esophageal tumors, mediastinal tumor, cardiospasm, aneurysm, varices, and substernal thyroid.

Carcinoma of the esophagus may in rare cases form protruding lesions similar to the granular mushrooming skin lesions. This type of malignancy may be differentiated by its shorter length, greater diameter, and rough surface.

Extra-esophageal tumors can be differentiated by demonstrating displacement of the esophagus or ruling out intrinsic growth when the mediastinum anterior to the esophagus holds the tumor.

Simple cardiospasm can be ruled out as a cause for slight esophageal dilatation by demonstrating the free passage of barium and the presence of a filling defect. When there is secondary cardiospasm caused by the tumor the demonstration of the filling defect is the only reliable means of roentgenological differentiation.

Tracheal stenosis should not afford difficulty in the differential diagnosis even in the cases giving a history of dysphagia.

Small polypi in the distal two-thirds of the esophagus may be mistaken for varices which, in general, produce smaller shadows. Either condition may cause severe hemorrhage, as in the case reported by Dickes, Knudsen and Franco.[3]

Histopathologically the tumors may be myoma, fibromyoma, polyp, or lipoma. Vinson, Moore and Bowing[17] reported a pedunculated hemangioma.

SUMMARY AND CONCLUSIONS

Pedunculated tumor of the esophagus is rare and may be encountered unexpectedly on routine examination since, in some cases, symptoms are mild or not elicited.

Tumors of this type arise in the uppermost portion of the esophagus due to redundancy and elasticity of the esophageal mucous membrane in this region which is greater there than in any other part.

Grossly these tumors are smooth, about one inch in diameter, variable in length and may have multiple projections distally.

Microscopically most pedunculated tumors arising from the hypopharynx are fibrolipomas.

A correct diagnosis is important because the tumors are amenable to surgical treatment in most cases.

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NONSPECIFIC ENTEROCOLITIS

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WE HAVE observed a number of cases of enteritis at postmortem which presented unusual features. One of these cases seems to be classified best as nonspecific enterocolitis but might be a variant of either granulomatous enteritis or ulcerative colitis. Other cases seem to be typical instances of chronic ulcerative colitis with exceptionally extensive involvement of the small intestine. Three cases, 2 of granulomatous ileocolitis and the other ulcerative colitis with small intestinal involvement, were complicated by amyloidosis. These cases are reported to illustrate the difficulty of making an unequivocal diagnosis in many instances of nonspecific inflammation of the small intestine. The case reports follow:

Case 1. *Granulomatous Jejuno-ileitis with Amyloidosis, Confused with Ulcerative Colitis during Life.*

H.M. This woman was first admitted to The Mount Sinai Hospital in February, 1936, because of lower abdominal cramps for three months, blood-streaked stools for two months and diarrhea for three weeks. Physical examination revealed a pale, chronically ill-appearing girl. The heart was slightly enlarged to the left and there was a soft systolic murmur heard loudest in the pulmonic area. The abdomen was soft and not distended. There was slight left lower quadrant tenderness. The tip of the spleen was just palpable. An intertriginous erythematous eruption was present.

Laboratory Data. Hemoglobin 55 per cent. White blood cells 12,800 per cu. mm., with 64 per cent polymorphonuclear leukocytes. Stools were liquid and guaiac test 4 plus. Sigmoidoscopy revealed congested, edematous but smooth mucosa. Blood urea nitrogen 8 mg. per 100 cc. Total protein 8.7 grams. Dysentery agglutinations were negative.

Barium enema failed to show any definite evidence of ulcerative colitis aside from slight loss of haustration in the lower descendens with atony. The ileum was not filled.

Progress. She received carbarasone and emetine therapy, in addition to several blood transfusions. She was discharged much improved on the nineteenth day. Her stools were liquid but less frequent.

Approximately a year later she was readmitted. For the preceding four months abdominal cramps were more severe and bowel movements more frequent. There had been an 8 pound weight loss. In addition, she had noted tender reddened areas over both legs which made walking impossible.

Barium enema now suggested a rather severe inflammatory process involving the entire colon except for the sigmoid and rectum and sigmoidoscopy was negative. Her temperature was 100.4° F. on admission, but in the next four days began to show daily spikes to 103° F., coincident with the appearance of new lesions of erythema nodosum. She was given several transfusions and was discharged after three weeks with a diagnosis of chronic nonspecific ulcerative colitis.

She did well for about sixteen months but had to be readmitted because of severe right lower quadrant pain for five hours. Physical examination showed the abdomen to be soft but there was slight tenderness and rigidity in the right lower quadrant. White blood cells 17,000 per cu. mm., with 66 per cent polymorphonuclear leukocytes. An appendectomy was performed and the surgeon's note is as follows: "On entering the peritoneal cavity, a large mass was found in the region of the cecum, which itself appeared normal. The appendix was thickened and inflamed. The major portion of the mass consisted of terminal ileum which was markedly thickened and indurated for 6 inches, with further thickening of its mesentery for an additional 3 inches proximally. This segment was reddened and its surface was lusterless. It presented the appearance of a nonspecific regional ileitis. The lesions stopped sharply at the ileocecal valve."

The pathological report was chronic and acute appendicitis.

The postoperative course was uneventful and in view of the operative findings, it was felt

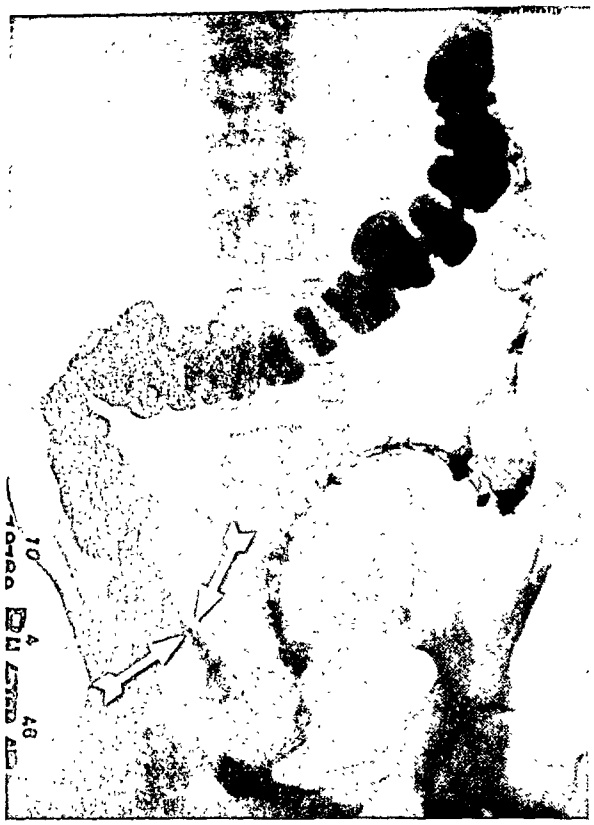


FIG. 1. Case 1. Colon examination after evacuation and introduction of air. Arrows indicate stenosed terminal ileum.

that she was probably suffering from regional ileitis, rather than colitis.

She did well after discharge and was married in 1939. Eight months later she again began to have abdominal cramps associated with five to eight movements per day. Each following winter for a period of a month or two she had exacerbations of her disease. In June, 1945, she first noticed bilateral ankle swelling which gradually spread upward to involve the thighs. Also, at this time, her face and eyelids became slightly swollen at night and two months before entering the hospital she noted that her abdomen was gradually becoming larger. Albuminuria was found a few months after the onset of the swelling and she was treated with lactoalbumin elsewhere for a week just before entering The Mount Sinai Hospital. Temperature on admission was 101.5° F. She appeared chronically ill; face and eyelids were pale and moderately edematous. There were signs of fluid at the right base, the heart was slightly enlarged and there was a systolic murmur audible all over the precordium. One observer felt an enlarged liver and spleen and elicited signs of fluid in the abdomen but others were unable to substantiate these findings. The sacrum and extremities were edematous.

Barium enema showed cecum and ascending colon filled with fecal material. Edges appeared to be somewhat serrated and the tip of the cecum was irregular. The terminal ileum was narrowed (Fig. 1). Barium meal examination showed a stenotic loop of bowel in the lower jejunum (Fig. 2). Adjacent to it there were several segments probably of proximal ileum which had lost their normal mucosal pattern. The changes suggested granulomatous jejunoileitis.

While she was in the hospital the profuse albuminuria continued unabated and the Esbach reaction reached 6 grams per liter. The urine also continued to show casts, red blood cells and white blood cells. The blood pressure was maintained at a level of approximately 120/70. Some observers entertained the diagnosis of amyloidosis while most favored the diagnosis of glomerulonephritis. The first Congo red determination was equivocal as some of the dye was excreted in the urine. A punch biopsy of the liver was negative for amyloid disease.

The fifth and last admission was two months later. She had done well until four days prior to



FIG. 2. Case 1. Barium meal. Arrows indicate stenosed ileal segment.

admission when she suddenly was seized with pain in the hypogastric region. Her stools were now diarrheic and foul-smelling. For the thirty-six hours preceding admission there had been neither bowel movement or flatus. There was persistent nausea and vomiting.

It was felt that a perforation of the small intestine had taken place. Another opinion was that she might have peritonitis secondary to renal disease. She developed severe oliguria with a rising blood urea nitrogen. An abdominal tap was performed and purulent fluid containing gram-positive diplococci (culture negative) was obtained. Roentgen examination of the abdomen was consistent with the diagnosis of a reflex ileus. Her condition was desperate and in spite of transfusion and penicillin therapy she showed no tendency to rally and died on the sixth day after entry.

Preliminary Anatomic Diagnosis. Regional enteritis involving jejunum and terminal ileum; acute fibrinopurulent pelvic peritonitis; amyloidosis of kidneys, spleen, adrenals, thyroid, heart; congestion and fatty infiltration of heart; papillary cystadenoma in a paraovarian cyst—left; decubitus ulcer.

This case is being reported in detail by Cohen and Fishman.

Comment. Postmortem examination in this case revealed typical chronic granulomatous jejuno-ileitis. There was no evidence to support the diagnosis made at one time during life of ulcerative colitis. Unfortunately the roentgenograms are not available for review but undoubtedly the interpretation was based upon minor deviations from the normal which were fitted to a tentative clinical diagnosis. The complicating amyloidosis will be discussed briefly in connection with Case III.

Case II. *Granulomatous Jejuno-ileitis with Amyloidosis.*

G.F., female, aged thirty-nine, was admitted six times to The Mount Sinai Hospital. First admission was in December, 1935, because of nine months of colicky, abdominal pain, which was most marked in the right lower quadrant and was associated with diarrhea and occasional bloody stools. There had been visible and palpable peristalsis noted the month before admission. A 57 pound weight loss occurred in the year preceding admission. Physical examination revealed an emaciated woman with a tender, orange-sized mass in the right lower quadrant. The stools were guaiac positive. Barium enema showed the ileocecal valve to be incompetent; the terminal ileum, which was filled for a distance of a foot, appeared to be constantly narrowed and irregular in outline. The changes suggested the possibility of granuloma of the small intestine. Barium meal examination also showed this stenotic lesion. At operation the cecum seemed to be free of disease. The distal ileum showed an extensive lesion reaching about 5 feet proximally from the ileocecal valve. The glands of the adjoining mesentery were markedly involved. An ileocolostomy was performed.

She was admitted five months later for the second time, and 2 feet of the distal ileum, cecum, and the lower part of the ascending colon were removed. The previously inflamed and thickened ileum now appeared as a small narrow tube without signs of inflammation and no glands were seen in the mesentery as on the first admission.

The patient did well for about a year but then was readmitted for the third time because of two months of diarrhea and cramp-like abdominal pain. Physical examination revealed only some tenderness in the right lower quadrant and periumbilical area. Barium meal suggested a recurrent ileitis indicated by marked irritability of the distal ileum which never filled well. Operation was considered inadvisable because of the extent of the disease process.

A month later, a right lower quadrant mass was found. At exploration a mass of agglutinated intestinal loops was found consisting of the distal portion of the ileum which was adherent to the bladder. Three feet of the terminal ileum were involved in an extensive inflammatory process and a secondary ileocolostomy with ileotransverse colostomy was carried out. Evidently in spite of an adequate resection at the first operation, the disease had recurred.

She was again admitted several months later because of weakness, anemia and weight loss. Roentgen examination showed a recurrence of the disease process. She was treated with transfusions and dietotherapy. Because there was improvement in her symptoms operation was deferred.

She was admitted for the sixth and last time about one year later because of burning about the anus and diarrhea. She exhibited the classi-

cal evidence of multiple vitamin deficiencies. Roentgen examination revealed segmental dilatation of the jejunum and ileum with tendency to constriction. The entire colon was narrowed. Because of the involvement of the whole gastrointestinal tract, it was decided that surgical intervention was inadvisable and accordingly chronic hospitalization was recommended.

She was admitted to Montefiore Hospital and died after seven months.

Anatomic Diagnosis. Status post jejunotransverse colostomy for ileitis; status post resection of ileum, cecum and ascending colon; amyloidosis of spleen, kidneys and adrenals, and amyloid nephrosis, small tuberculous caseous focus in the left lung.

Microscopic examination (jejunum) showed "one area of homogeneous, pale, pink-staining material about some of the capillaries and small arteries in the tunica propria, may be amyloid."

Case III. *Acute Ulcerative Jejuno-ileitis. Dormant Ulcerative Colitis. Amyloidosis.*

J.N. This man, aged twenty-nine, was admitted in November, 1942, because of recurrent diarrhea for ten years. In 1933 he had been hospitalized elsewhere for abdominal cramps, diarrhea of six to eight loose, watery stools per day with occasional blood and weight loss. A diagnosis of tuberculous enteritis was made although roentgenograms of the chest were negative. After medication and sunlight therapy, movements were reduced to about three daily. Later, diarrhea, cramps, weight loss returned as well as pain and drainage about the rectum.

Several months later he was admitted to another hospital for the same complaints and remained there approximately two years. Rectal examination revealed a flat condylomatous mass on the left side of the anus which extended 5 cm. into the rectum. The stool was full of gross blood; no amebae; culture negative. A biopsy of the skin from the rectal area was reported as tuberculosis with typical epithelial proliferation. Excision of perianal fistula showed chronic suppuration with granulomatous changes. Roentgenogram of the chest negative. Barium enema—very advanced colitis involving almost the entire colon, probably ulcerative in type. Proctoscopy—polyposis. While in that hospital he had occasional temperature rises to 101 and 102.3° F. He was placed on a low residue, high caloric and high vitamin diet. Pain and discharge continued from the anal, fistulous lesion—at first considered to be tuberculosis but later thought to be due to ulcerative colitis. Cramps, diarrhea and weight loss continued for months in spite of medication directed against them. Incision and drainage of pararectal abscesses were carried out. Weight fluctuated while in the hospital and when he was finally discharged his weight was 124 lb. as against 110 on entry two years before.

Subsequently he had intermittent diarrhea, usually associated with an upper respiratory infection. He was well in the summer months, but the exacerbations returned in the winter. Seven to eight months before entry he noted sores at the corners of his mouth. For two weeks before entry, during an attack of grippe, severe diarrhea, cramps and vomiting supervened and there was a 12 pound weight loss in a week. For these reasons he sought admission.

Physical Examination. An emaciated man who appeared acutely and chronically ill. Tongue smooth, beefy red and fissured, cheilosis. Lungs clear. Heart, soft systolic murmur at the apex. Blood pressure 90/50. Abdomen negative. There was early clubbing of the fingers and toes.

Laboratory Data. Hemoglobin 75 per cent. White blood cells 2,200 per cu. mm., with marked shift to the left. Stool, guaiac positive. Albumin 2.3 gm. and globulin 1.7 gm. Other blood chemical determinations were normal. Agglutinations for dysentery were negative.

Course. At first was marked by irregular spikes of temperature and liquid, bloody diarrhea of ten to fifteen movements per day. Nine days after entry he complained of sticking pain in the left lower chest. Abdominal distention appeared and progressed and finally respirations became rapid and shallow. The pulse became imperceptible, general tenderness developed all over the abdomen and it was felt that a perforation had occurred. He died soon after.

Postmortem examination revealed chronic ulcerative colitis (relatively dormant), hyperacute jejuno-ileitis with a high jejunal perforation, fecal peritonitis (generalized) and generalized amyloidosis. Practically all organs showed some amyloid tissue.

Comment. "The extensive ulcerative jejunoileitis has been completely investigated as to cause. The mesenteric arterial tree did not reveal changes which could account for so severe a lesion. Amyloid was thought of, but the early

ulcerations which were especially examined did not show evidences of amyloidosis. The cytology of the ulcer is not characteristic of any of the known granulomata. Bacteriologic studies did not reveal any unusual type of bacterium. The lesions therefore have to be classified as 'nonspecific.' " (Dr. P. Klemperer)

DISCUSSION

It is generally agreed that the majority of cases of nonspecific ulcerative colitis begin around the rectosigmoid. However, approximately 5 to 15 per cent of the cases show involvement of the segmental type which more often occurs on the right side. It is also well known that occasionally the disease process may pass the ileocecal valve to involve the terminal portion of the ileum.[3,19] McKittrick and Miller,[15] in a review of 149 cases, stated that in 1.3 per cent the disease process extended into the terminal ileum. Schlicke and Bargen[21] in a study of fulminating ulcerative colitis reported that at necropsy all their fatal cases showed diffuse involvement of the entire large bowel: only one showed lesions in the terminal ileum; how extensive was not stated. There were 2 case reports[5,6] of individuals suffering from ulcerative colitis with extension to the ileum but the extent of involvement was not mentioned.

The only report found in the literature describing involvement of the small intestine by chronic ulcerative colitis beyond the terminal foot or two of ileum is that of Crandon *et al.*[8] They reviewed 16,500 consecutive autopsies from the Mallory Institute. There were 44 cases in which chronic ulcerative colitis was considered the primary cause of death. In 17, or 39 per cent, the small intestine was involved; in the majority it was confined to the terminal 30 cm. of ileum. In 3, however, ulceration extended throughout the lower third of the ileum. In addition, they stated that the incidence of perforation of the small bowel in ulcerative ileitis was 24 per cent. They described 2 cases in which at operation the ileum looked normal but perforation occured after ileostomy. In 1 case, it was involved 60 cm. above the ileocecal valve; in the other, lesions were noted 30 cm. above the ileocecal valve, 15 cm. above the site of the ileostomy. The ileum grossly showed the same diffuse process which was seen in the colon. The ulcers were sharply demarcated and varied in size and shape. Microscopic examination revealed the mucosa to be absent or necrotic. There was edema and thickening of the submucosa with marked polymorphonuclear and lymphocytic infiltration in the muscularis like the lesions in the colon. They point out that in cases where the ileostomy drainage does not become solid, one should be suspicious that there is involvement above the ileostomy with consequent danger of perforation and peritonitis.

Cases II, III, and IV were also complicated by amyloidosis. This is an unusual finding. No reports have been found in the literature in which amyloidosis has complicated regional enteritis. Moschcowitz[16] reported a case of ulcerative colitis with amyloid degeneration. The only other report found is that of a young man with severe ulcerative colitis who also had amyloid degeneration of the kidneys, liver, spleen and adrenal glands.[7] The rarity of amyloidosis is curious when one realizes that both chronic ulcerative colitis and chronic enteritis are long standing diseases characterized by persistent infection. There is no apparent reason why amyloid occurred in the present cases and not in others where there were extensive abscesses and suppuration. It is within the realm of possibility that more instances occur than is suspected. There is recorded in our autopsy files a case of long standing ileitis where the main complication was a huge retroperitoneal abscess which persisted in spite of all surgical and chemotherapeutic measures. Postmortem examination disclosed a huge retroperitoneal abscess with lumbar osteomyelitis. In addition there was amyloid degeneration, the pathogenesis of which could not be determined.

The clinical manifestations of gastrointestinal amyloidosis have been adequately discussed in the literature.[2,14,18,19] There are

several cases reported in Henke and Lubarsch[13] of patients with amyloid disease without ascertainable cause who died of gastrointestinal bleeding. It is also mentioned that in amyloid disease the intestine usually participates and the deposition in the muscles causes paralysis of peristalsis with mechanical obstruction resulting therefrom. The present cases emphasize that some of the intestinal symptoms in the occasional case of long standing enteritis and ulcerative colitis may be due to amyloidosis.

Case iv. *Nonspecific Enterocolitis.*

S.K., a twenty-five year old married furniture salesman, was admitted to The Mount Sinai Hospital in 1941 complaining of abdominal pain and fever for four months. Past history revealed a 15 pound weight loss in the four months preceding entry, an appendectomy eight years ago with no unusual features, and several episodes of red swellings on the right thigh associated with fever. Four years ago he noted the gradual onset of anorexia, malaise, fever and diarrhea. The diarrhea greatly increased in severity so that after six months it amounted to twelve watery movements per day without blood. In addition, he now had daily elevations of temperature to 103–104° F., marked anorexia, weakness, 90 pound weight loss, and generalized abdominal tenderness. He was admitted to another hospital where he was given a high caloric diet, transfusions, and supportive therapy. He was there for nine weeks and gradually improved. After discharge the improvement continued and he gradually attained his former state of health. He was well for a year and then had a mild recurrence for six months with complete recovery. Four months before entry, he began to run a low grade fever and diarrhea returned. He was put to bed and given kaomalgin and sulfathiazole for a seven-week period. He improved upon this therapy, but because of persistence of the fever, was referred to the hospital.

Examination showed a well developed and well nourished male. Temperature 100.4° F. Pulse 74 beats per minute. Respirations 18 per minute. Blood pressure 135/85. Lungs were clear. Heart showed a reduplication of P-2. The abdomen was slightly distended with a well healed right lower quadrant scar. There was some tenderness in both lower quadrants. Rectal examination was negative and there was slight clubbing of the fingers.

Laboratory Data. Hemoglobin 102 per cent. Red blood cells 6.3 million per cu. mm.; white blood cells 11,600 per cu. mm., with 20 nonsegmented forms and 45 segmented polymorphonuclears; 280,000 platelets per cu. mm. Urine negative. Blood urea nitrogen 11 mg. per 100 cc. Fasting blood sugar 80 mg. per 100 cc. Icteric index 3. Dysentery agglutinations negative. Wassermann reaction negative. Stool culture negative. Electrocardiogram negative. Roentgenogram of the chest negative. Sigmoidoscopy normal.

Barium enema showed no abnormalities in the large bowel. Barium meal examination showed "the stomach and duodenum to be normal. The terminal ileum for a distance of about 5 inches is constricted, the margins serrated. The appearance is that of regional ileitis" (Fig. 3).

The patient ran a fever of about 101° F. daily and had one or two semisolid or solid stools a day. He was given sulfathiazole for eight days without any effect. After three weeks of observation, he was explored (Dr. L. Ginzburg). "Beginning at the ileocecal junction, the first foot of ileum was like a pipe. The walls were thick, edematous, and rigid, as was the mesentery. The second foot was more nearly normal, but there was also slight edema of the wall. The third foot of ileum and mesentery were exactly similar to the first foot. Beginning about a foot from the ligament of Treitz, about 12 inches of jejunum were thick, stiff, and the mesentery was thickened exactly like the picture seen in the terminal foot of ileum. The intravening gut was not absolutely normal, but showed slight thickening and edema of the wall. There were hemorrhagic blotches and moderate enlargement of the lymph glands throughout the mesentery. Because of the extensiveness of the disease, it was impossible to do any operative procedure." His postoperative course was uneventful. His temperature subsided. He had one to two solid stools a day and he left on the sixteenth hospital day, apparently in a remission of his illness.

The patient did very well for approximately six months when he was once again admitted to another hospital for symptoms of obstruction but he was not subjected to any operative procedure. Following this, his general condition re-

mained good for the next three years although another roentgenogram taken one year after discharge from The Mount Sinai Hospital gave the impression that the diseased loops of intestine were somewhat more rigid and narrowed (Fig. 3). There was, however, no delay in motility. About a year before readmission to The Mount Sinai Hospital, in March, 1946, he again noted gradual weight loss and anorexia.

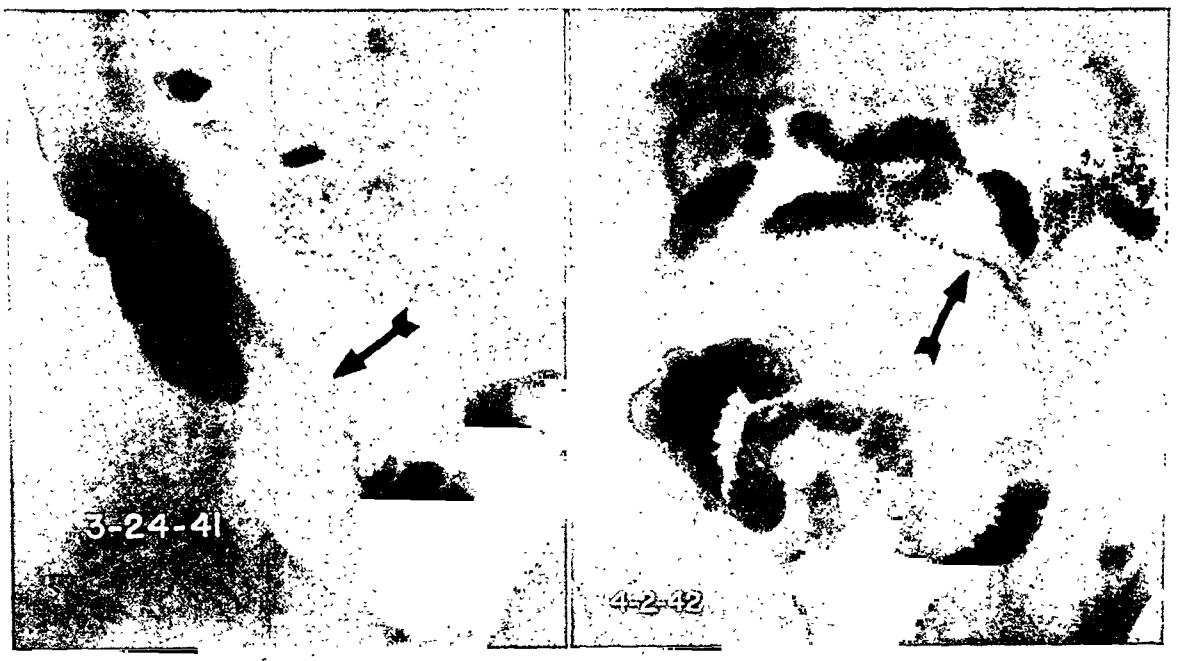


FIG. 3. Case IV. 3/24/41, stenosis of terminal ileum; 4/2/42, apparent stenosis of jejunal loop.

Three months before entry, there was an increase in the number of stools so that he was having six to ten loose stools per day. There were occasional episodes of fever and chills at night with elevation of temperature to 101° F., with return to normal in the morning. In addition, during the past few weeks, he had generalized abdominal cramps relieved by passage of gas or by having a bowel movement. There was a 35 pound weight loss in the last year.

Physical Examination. Temperature 102.6° F. Pulse 86. Respirations 22. Blood pressure 115/75. Examination showed a thin, poorly nourished white male with evident signs of dehydration. There were no abnormalities in the heart or lungs. The abdomen was slightly distended with diffuse tenderness and general tympanitis. The liver percussed two fingers below the costal margin.

Laboratory Data. Stool watery; guaiac test 2 plus, no free fat seen, many pus cells. Urine negative. Hemoglobin 50 per cent. Red blood cells 3.9 million per cu. mm. White blood cells 9,300 per cu. mm., with segmented forms 53 per cent; non-segmented 28 per cent; lymphocytes 15 per cent; monocytes 5 per cent. Blood urea nitrogen 14 mg. per 100 cc. Chlorides 575. Carbon dioxide 47 volumes per cent. Total protein 5.1 grams. Cholesterol 100 mg., calcium 8.2 mg., phosphorus 2 mg. per 100 cc. Roentgen examination of the gastrointestinal tract showed considerable dilatation of the small intestine (Fig. 4). Barium enema showed an ulcerative colitis involving at least the sigmoid and descending colon. The bowel was somewhat narrowed in this region. Its edges were serrated and post-evacuation films showed evidence of polypoid hyperplasia. Portions of the ileum were visualized and showed areas of constriction and dilatation.

Throughout his hospital stay he ran a septic course with temperatures ranging as high as 103° F. His stools continued unchanged. During the second hospital week, he developed signs of peritonitis, with high fever and marked abdominal distention. Wangensteen drainage and transfusions proved unavailing and he died on the twentieth hospital day.

Postmortem examination revealed serofibrinous peritonitis. There was a diffuse enterocolitis

involving the gastrointestinal tract from jejunum to sigmoid with ulceration, edema and scarring.

Gastrointestinal tract: The esophagus is not dilated. There are several superficial mucosal ulcerations, the largest of which is 1.5 cm. in diameter. The gastric mucosa presents the usual rugal pattern with no evidence of atrophy or other gross changes. There is diffuse hyperemia slightly rigid. The ulcerations and intervening islets of hyperplastic mucosa have a parallel longitudinal disposition. The lumen appears somewhat narrowed. The mesentery of the ulcerated segments is thickened and edematous and contains many large hyperplastic lymph nodes. The appendix is not present.

The entire colon, except in a small dilated portion of the transverse colon, shows diffuse



Fig. 4. Case iv. 1946. Dilated small intestine. Typical ulcerative colitis involving the entire large bowel.

of the duodenum without ulceration. The upper portion of the jejunum shows diffuse moderate hyperemia with occasional superficial ulcerations, some of which have undermined edges. In the mid and lower jejunum, the ulcerations are widespread, imparting a honey-combed appearance to the mucosa. Throughout the ileum there are extensive areas of ulceration of various sizes and shapes, frequently involving the entire circumference of the intestine, exposing the muscularis. The intervening mucosal islets are hyperplastic. The entire process in the small intestine is segmental, there being large stretches of ulcer-free bowel, and other areas in which there are many superficial and deep ulcers of varying size and shape and with undermined edges. In many of the ulcerated areas the wall of the small intestine is thickened. This is most pronounced in the terminal ileum which is extensive ulceration with polypoid islets of hyperemic, hyperplastic mucous membrane and marked thickening of the wall. In the dilated segments of the transverse colon, the typical picture of ulceration and intervening islets of hyperplastic tissue is not found. Here the mucous membrane is either intact or there are superficial, fresh ulcerations of various sizes and shapes with undermined edges as found in the small intestine. The wall of this portion of colon is not thickened. The rectosigmoid is diffusely hyperemic and shows several large deep, serpiginous ulcers. The bases of many of the ulcers throughout the intestine are necrotic; those in the descending colon have transverse folds. The serosa of the small and large intestines is focally dull and granular. There are rare, single, firm, dark purple nodules on the surface of the large intestine. No tubercles are found.

Microscopic Examination. Jejunum, ileum and colon: The lesions of the jejunum, ileum, and large intestine are essentially similar and are described together. The ulcers are widespread, usually extending through the mucosa, occasionally through the submucosa to the muscularis propria, rarely all the way through the intestinal wall to the serosa. The edges of the ulcers are punched out, sloping or undermined. There is an associated exuberant chronic inflammatory reaction at the bases and the margins of the ulcers, resulting, in some areas, in conspicuous thickening of the intestinal wall. The reaction affects all the coats, but is most marked in the submucosa. It consists of hyperemic granulation tissue, diffusely infiltrated by large numbers of plasma cells, lymphocytes and large mononuclear cells with the plasma cell predominating. There are small foci of necrotic acute inflammatory exudate on the mucosal aspect of a few of the ulcers. Elsewhere in the intestinal wall proper there is no evidence of an acute inflammatory reaction. The serosa and subserosa are generally markedly thickened and show a chronic inflammatory reaction similar to that in the wall of the intestine, except that the fibrous tissue reaction here overshadows the cellular inflammatory reaction. A membrane composed of fibrin, polymorphonuclear leukocytes, large mononuclear cells, and a few multinucleated cells is present on the peritoneal surface of many of the sections, superimposed upon the chronically inflamed and thickened serosa. The mesenteric and pericolic fat share in the chronic inflammatory reaction, but to a lesser extent than that present in the intestinal wall.

Nowhere in the intestine is a granulomatous response in evidence. No parasites are seen and special bacterial stains showed gram-positive and gram-negative bacilli and cocci on the mucosal surfaces of many of the lesions.

Terminal ileum: The picture in the terminal ileum differs slightly from that in the rest of the intestine. Here there is diffuse ulceration with one ulcer extending through the muscularis to the serosa. On either side of this deep ulceration the muscularis propria is hyperplastic. The wall of the intestine at the base of the more superficial ulcer consists of chronically inflamed granulation tissue. There is fibrosis of the serosa and subserosa. The chronic inflammatory cellular response is similar to, but less intense, than that seen elsewhere in the intestine.

Dr. Paul Klemperer (Pathologist to The Mount Sinai Hospital) stated that this was contrary to any previous experience he had with "chronic nonspecific granulomatous enteritis."

DISCUSSION

The usual course of nonspecific granulomatous disease of the small intestine through subacute and chronic phases with healing by scarring and subsequent stenosis has been adequately described.[4,9,23] Little mention is made in the literature of possible resolution or of healing without stenosis. Most observers feel that recovery is possible only during the acute stage. Crohn[9] states that the majority of the acute cases resolve but that "once a lesion is established by radiographic evidence, the deformity of the bowel remains whether the clinical symptoms do or do not improve." Donald and Brown[11] report that "the experience at the Mayo Clinic coincides with that of Crohn in that post mortem records do not reveal any instance of healed chronic regional enteritis, although in some cases of acute fulminating disease resolution apparently takes place." Sussman and Wachtel[22] refer to a presumed case of acute jejuno-ileitis with apparent complete recovery. Ginzburg and Garlock[12] reported without details a case in which death occurred due to another cause and where autopsy disclosed complete healing. A search of the literature failed to disclose any other postmortem report of diffuse, subacute or chronic enteritis in which resolution took place.

In 7,642 consecutive autopsies at The Mount Sinai Hospital from 1927 to 1947 there have been 18 cases of granulomatous jejuno-ileitis in which death occurred due to this disease. In 17, typical granulomas with healing by scarring were found. In the present case the lumen of the intestine was not narrowed; there was no significant submucosal fibrosis nor any evidence of a granulomatous process. The argument might be advanced that since a biopsy was not taken at the time of operation in 1942, this is not necessarily a case of regional enteritis. In

favor of the diagnosis was the usual roentgen appearance of stenosis of jejunal and ileal loops both in 1941 and 1942—five and four years respectively before death. The colon roentgenologically appeared normal at these times. There is also the evidence of the surgeon, who had particular experience in this disease, that "the first foot of ileum was like a pipe," "the third foot of ileum and . . . about 12 inches of jejunum were thickened and stiff." These descriptions correspond to what ordinarily would be considered granulomatous disease. On the other hand, the surgeon might have been deceived by the induration of edema and ulceration. Certainly these could have accounted for the roentgen appearance.

The case might correspond to those reported by Ginzburg and Garlock[12] and by Alvarez[1] in which extensions into the colon from chronic enteritis occurred. However, in their cases the small intestine remained stenosed. A further possibility is that the case is one of primary ulcerative colitis with small intestinal involvement but the course would be most atypical. It would have to be assumed that the small intestine was the predominant site of the disease for five years and that colonic involvement became apparent only shortly before death. For these reasons we suggest tentatively that a more general designation, nonspecific enterocolitis, to be given to this case.

Four Cases of Ulcerative Colitis with Extensive Small Intestinal Involvement.

Case v. T.L. This was the first Mount Sinai Hospital admission of a nineteen year old girl for diarrhea, vomiting, anemia, and rectal bleeding. Past history was essentially negative. She had been trying to become pregnant for eight to nine of her nineteen months of married life, and five months before entry she conceived. A month later, she began to vomit several times a day and this continued with increasing severity. A month later, she began to have five to six watery bowel movements per day and this persisted. After a few weeks she began to pass three to four teaspoonfuls of red blood with the stools. She lost weight and strength markedly, and her condition deteriorated in spite of iron and copper medication. Three weeks ago, she ran a temperature to 101° F. daily. After five days, her normal pallor increased and her temperature rose to 103° F. Her physician gave her 5 grain tablets of sulfanilamide and cyanosis resulted. She was taken to a local hospital and given a blood transfusion. Temperature rose to 106° F., she had a shaking chill; cyanosis and icterus appeared, and she aborted spontaneously five days later. She bled profusely and received a second transfusion. Chill and temperature elevation to 104° F. resulted. Two days before she was transferred to The Mount Sinai Hospital, her temperature rose to 106° F.

Physical examination revealed a pale, exsanguinated, stuporous, nineteen year old girl. There were hemorrhages in both fundi. The lungs and heart were not remarkable. The pulse was of the Corrigan type with a pistol-shot sound heard over the femoral arteries. Blood pressure 130/0. Hemoglobin was 14 per cent on admission and red blood cells were 1,000,000 per cu. mm. White blood cells 19,000 per cu. mm., with a normal differential. Blood urea nitrogen 49 mg. per 100 cc. Fasting blood sugar 115 mg. per 100 cc. Cholesterol 99 mg. per 100 cc. Cholesterol ester, trace. Chloride 655 mg. per 100 cc. Total protein 4.6 grams. Urine showed occasional clumped white blood cells and an occasional hyaline cast. Blood culture was negative. Electrocardiogram showed sinus tachycardia, rate 130. RS-T transition depressed in leads I, II, III. T-waves low in the standard leads, T-4 diphasic.

Temperature was 103° F. on admission and remained between 103 and 106° F. during her hospital stay. Gynecologic examination revealed no evidence of any pelvic sepsis and there were no abdominal signs of peritonitis. Two days after entry, she showed a bilateral foot drop and diminution in sensory modalities as found in peripheral neuritis. There was a recurrence of rectal bleeding and in spite of practically continuous blood transfusions, her condition became worse and she died eight days after admission.

Postmortem Examination. "The duodenum and upper part of the jejunum reveal no gross changes. The mucosa in the distal part of the jejunum is congested and the signs of inflammation become more severe as one proceeds down the intestinal tract. The mucosa in the lower part of the ileum is a dirty, brownish-red and is covered with necrotic membranous tissue which strips away with ease. The wall of the

bowel is extremely thin. The entire large intestine was the seat of a severe diffuse ulcerated process."

Dr. Paul Klemperer made the following comment on this case: "Pathology of the intestinal lesions is not unusual. Histopathology reveals severe vascular involvement (acute arteritis) of the submucosa of the colon and in the necrotic terminal portion of the ileum. These arteries are within the edematous submucosa and not adjacent to severe inflammation. It cannot be ruled out that the severe vascular lesions are responsible for the destruction of the mucosa."

Case vi. *H.P.* This twenty year old pharmacy student entered The Mount Sinai Hospital for the second time because of rectal hemorrhages and diarrhea for two years. He had been admitted six months previously for ulcer symptoms. He was kept on medical therapy and was discharged improved. No operation was performed. While vacationing he had occasional attacks of diarrhea and occasionally noted some blood after defecation. On his return he was admitted to the Hospital since a gastrointestinal series supposedly showed an ulcer. He did well till one month ago when he began to have abdominal cramps and slight diarrhea. The number of stools gradually increased and they were now bloody. Because of the increase in symptoms with loss of weight and with fever he was admitted again.

Physical examination revealed a pale, chronically ill-appearing male complaining of abdominal pain. Temperature 101.8° F. Pulse 112. Respirations 22. Blood pressure 110/80. There was a soft apical systolic murmur. Abdominal examination revealed slight left lower quadrant tenderness and moderate distention. There was diffuse tenderness on rectal examination. It was felt that he was suffering from chronic nonspecific ulcerative colitis.

Laboratory Data. Erythrocyte sedimentation rate 71 mm. per hour. Hemoglobin 70 per cent. Red blood cells 4.15 million per cu. mm. White blood cells 12,200 per cu. mm., with a normal differential count. Urine showed very faint trace of albumin and occasional red blood cells and white blood cells on microscopic examination. The chemical determinations of the blood were normal. All agglutinations for dysentery organisms were negative. Stool culture revealed *B. coli* and enterococcus. Total protein 4.9 grams. Roentgenogram of the chest was negative. Barium enema revealed ulcerative colitis involving the large intestine from the cecum to the region of the splenic flexure. In the descending colon the mucosal pattern showed an irregularity in that the longitudinal striations were fuzzy in outline, presumably due to the same disease. Sigmoidoscopy showed marked involvement with large and small ulcers with free bleeding.

Intensive therapy had no influence on his disease. After six weeks he showed no improvement; diarrhea continued, fever persisted, hemoglobin kept falling and the weight loss continued. Ileostomy was decided upon as the only possible hope to stay the rapidly retrogressive course. He did fairly well immediately after ileostomy, but on the fifth postoperative day he began to have marked rectal bleeding. The following day marked abdominal cramps started, accompanied by distention and moderate tenderness in the left lower quadrant. The distention increased and a yellow serous discharge came out around the ileostomy. His course was relentlessly retrogressive, signs of peritonitis increased and he died on the tenth postoperative day.

Anatomic Diagnosis. Status post ileostomy for ulcerative colitis—ten days; subacute ulcerative colitis of entire colon with three perforations in cecum and transverse colon; ulcers of ileum with perforation; generalized serofibrinopurulent peritonitis.

Gastrointestinal Tract. The duodenum, jejunum and ileum are extremely distended. Their mucosa shows in several instances hemorrhagic areas. The mucosa of the ileum shows four sharply punched out deep ulcerations, each of which measures 3–4 mm. in diameter. One of these ulcers has perforated into the peritoneal cavity. The wall of the small intestine is extremely edematous. The ileum is transected 5 cm. proximal to the ileocecal valve. The entire colon is the seat of extensive changes.

Case vii. C.A. The first Mount Sinai Hospital admission of a twenty-six year old shipping clerk for bloody diarrhea of five years' duration. Past history was essentially negative. Five years ago he first noted onset of diarrhea; stools were formed but contained streaks of blood and mucus. He went to another dispensary where various forms of therapy were tried, but the diarrhea became progressively worse. It continued relentlessly for a year and he finally was hospitalized and remained so for five months. He received some benefit only from

Bargen vaccine and at discharge was having only five to eight semiformed stools per day. He continued the vaccine therapy at home but did not seem to improve much more. After a year he went to another physician who tried autogenous stool vaccine, also without much success. Several transfusions seemed to give temporary aid. In the past six to eight months the diarrhea became very severe and he was having twenty to twenty-five bloody stools per day. In the last few months he noted some exertional dyspnea with crampy pain in the arms and legs, coming on spontaneously. Ankle edematous, friable, rectal mucosa, but no ulcerations were seen.

Because of the lack of response to any therapy, an ileostomy was deemed advisable and he was prepared for this operative procedure by many transfusions. When the hemoglobin reached 69 per cent, an ileostomy with division of the ileum was carried out. He did well until the sixth postoperative day when he had a generalized convulsion characterized by cyanosis, abdominal twitching. Carpopedal spasm was present, but there was no Chvostek sign. In spite of intravenous calcium medication he

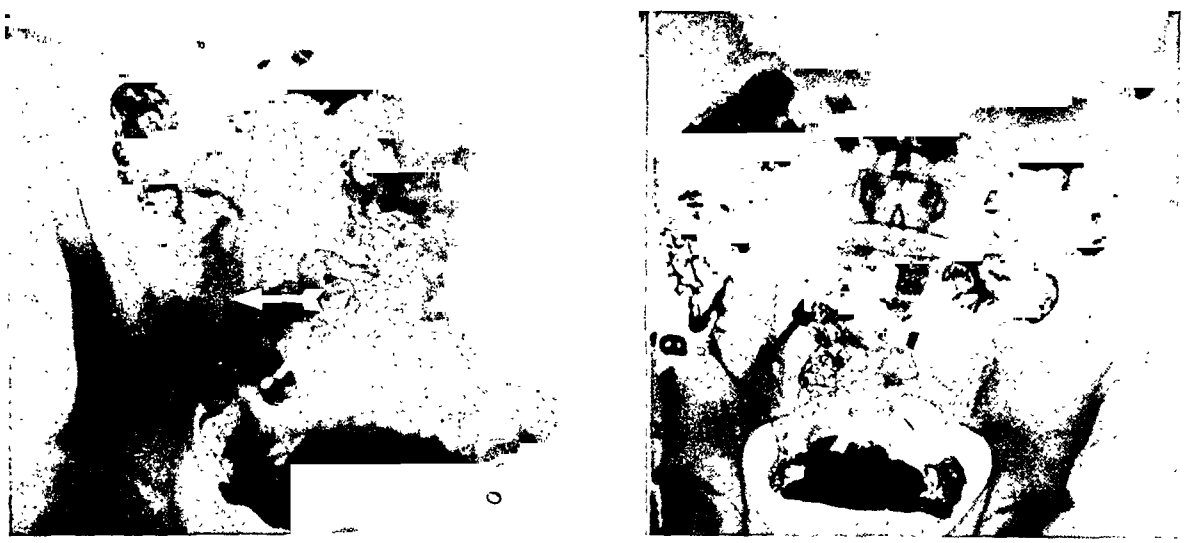


FIG. 5. Case VIII. Constant deformity and apparent stenosis of terminal ileum.

swelling was present for the last month before entry into The Mount Sinai Hospital.

Physical examination revealed an anemic, emaciated male complaining of diarrhea. Temperature 99.2° F. Pulse 88. Respirations 20. Blood pressure 110/80. There was a soft apical systolic murmur. The abdomen revealed a slightly tender, spastic sigmoid; the left kidney was palpable. There was moderate ankle edema, but examination was otherwise negative.

Laboratory Data. Hemoglobin 25 per cent. Red blood cells 2,500,000 per cu. mm. White blood cells 7,000 per cu. mm., with 80 per cent polymorphonuclear leukocytes. Urine was negative. Wassermann reaction was negative. Blood urea nitrogen 10 mg., fasting blood sugar 75 mg., cholesterol 135 mg., calcium 8.8 mg., phosphorus 4.6 mg. per 100 cc. Total protein 6 grams. Albumin 3.1 grams and globulin 2.8 grams. Stool guaiac test was positive and stool culture revealed *B. coli*. Sigmoidoscopy—had three more seizures and became semicomatose. A neurological consultant felt that these were toxic manifestations. His abdomen became distended, the pulse faded and he died.

Postmortem Examination. "Beginning in the distal portion of the jejunum and extending throughout the most of the ileum with only a few small areas being excluded, the mucosa presents a distinctly purplish red color. Throughout there are many shallow transverse situated ulcerations. Peyer's patches are considerably enlarged and contain punched out areas. There are also areas in which there are granular greenish and reddish deposits on the mucosal surface. The distal portion of the ileum is not involved. From the hepatic flexure down, the appearance is that of chronic nonspecific ulcerative colitis."

CASE VIII. M.C. This forty year old taxi driver entered The Mount Sinai Hospital for

the first time in January, 1944, complaining of diarrhea, occasionally associated with streaking of blood and abdominal cramps. He was given a constipating diet and sulfaguanidine, but the diarrhea was not relieved. Sigmoidoscopy was done by his physician and was negative. He was referred to the hospital as a possible right-sided colitis.

Physical examination showed a moderately well developed, well nourished man with clubbing of the fingers. There was a soft systolic blow on the aortic area. A right direct and indirect inguinal hernia was present.

Laboratory Data. Hemoglobin 93 per cent. White blood cells 11,300 per cu. mm., with 73 per cent polymorphonuclear leukocytes. Stool guaiac test was negative. Erythrocyte sedimentation time fifty-eight minutes. All agglutinations were negative. Barium enema showed an increase in the haustral markings of the large bowel without evidence of ulceration or change in the mucosal pattern. Irritability of the caput coli and the terminal ileum was noted (Fig. 6). A small intestinal series showed a constant irregularity and irritability of the terminal ileum and a deformity of the caput coli considered to be due to granulomatous disease (Fig. 5). Stools were persistently guaiac positive. They gradually became formed and less in number. The temperature which had been 103° F. on admission fell to normal on the fourth day. He gained 10 pounds and became asymptomatic.

In two months he returned because of recurrence of his symptoms three weeks after discharge. Physical examination was essentially as on the first admission except that now the spleen was just palpable. He was operated on by Dr. G. D. Oppenheimer on April 12, 1944. The surgeon found that "the terminal 3 feet of ileum were congested, dull, thickened and mushy to palpation. The small bowel above this was normal. Similar disease was seen in the cecum, ascending, transverse and descending colon down to the middle of the sigmoidal segment. The ileum was divided about 4 feet from the ileocecal valve and an ileorectosigmoidal anastomosis was made." The patient did well postoperatively and was discharged after three weeks with stools which were formed and non-bloody but frequent. This was explained on the basis of low implantation of the ileum in the rectosigmoid.

He returned in six weeks for an ileocolic re-



Fig. 6. Case VIII. Mucosal pattern of large intestine within normal limits. In retrospect, some fragmentation of the pattern is suggested.

section. Since discharge he had had eight to nine movements per day but for the last week before entry they had increased to eighteen to nineteen per day. In addition there had been a 5 pound weight loss, some anorexia and low abdominal pain after bowel movement.

Physical examination revealed a thin, chronically ill, cyanotic man with marked clubbing of the fingers and toes. Liver and spleen were now both palpable one finger below the costal margin, and rectal examination revealed a spastic tender rectum with large areas of scarring but no palpable ulcerations. Sigmoidoscopy showed normal mucosa for a distance of 22 cm. Hemoglobin 89 per cent. White blood cells 13,000 per cu. mm., with a normal differential count.

The patient was explored with the intention of dividing the sigmoid in preparation for a subtotal colectomy and terminal ileectomy. At operation the free sigmoid above the anastomosis was found to be thickened and badly diseased. The anastomosed ileum was thickened and diseased for about 6 inches proximally. The anastomosis was taken down, the sigmoid turned in and the proximal sigmoid and ileum were brought out as stomas on the abdominal wall. Examination of the resected 25 cm. of ileum showed the following: "Specimen consists of a loop of ileum with mesentery measuring 25 cm., half of which shows severe ulceration in a general transverse direction with the

base of the ulcers grayish and the wall of the ileum very hemorrhagic. In the area where the ulcerations are the severest, the bowel was torn. Near this end there is an anastomosis, a short loop of colon not more than 2.5 cm. being anastomosed to the ileum. There are still sutures present in the anastomosis. The mucosa of the anastomosed colon is pale but shows some small defects.

"Pathologic diagnosis: Segment of ileum showing extensive nonspecific transverse ulcerations with foreign body granulomata in the submucosa."

There was considerable spilling into the peritoneal cavity during the procedure. Peritonitis developed. There was wound separation and formation of a fecal fistula about the ileostomy site. These gradually subsided. In the next six weeks with diet, amigen, and transfusions he regained 20 pounds and re-operation was contemplated in the hope of re-establishing the continuity of the intestinal tract. However, he developed many episodes of intestinal obstruction, successfully combatted with the aid of a Miller-Abbott tube. By the end of the second month he no longer showed improvement and his condition gradually grew worse in spite of all measures, and death finally occurred after five months of hospital stay.

Postmortem examination revealed that the ileum was divided 42 inches above the ileocecal junction. The duodenum appeared normal. The portion of the ileum up to the ileostomy was extremely dilated, moderately thickened, the mucosa was dark red and swollen with prominent plicae circulares. The mesenteric lymph nodes were enlarged, discrete, firm, shotty, and on section were uniformly pale. The terminal and excluded ileum was thin walled; the mucosa was thin and dark red with a moderate number of small, sharply punched out irregular ulcerations reaching down to the muscularis. The cecum, appendix and entire colon were all involved in an ulcerative process which was most severe in the cecum and gradually diminished in severity distally.

Microscopic Examination. Four sections of colon show characteristic changes of ulcerative colitis; the excluded ileum, multiple ulcerations.

Comment. Cases V to VIII again illustrate that chronic ulcerative colitis may involve the small intestine much beyond the terminal foot or two, and that jejunum and ileum may be involved in spite of a normal terminal ileal segment. It is important for the surgeon to realize this fact so that when he does an ileal anastomosis or an ileostomy he will be sure to be well above any diseased area in the small intestine. The nature of the small intestinal involvement is not determined definitely from the present cases. In one case the lesions might have been due to shock.[17] In another, amyloid might have played a part but this is unlikely. Presumably then the changes are of the same nature as those in the colon. The condition may be mistaken clinically and roentgenologically for granulomatous ileocolitis. Case VIII particularly illustrates that a thickening and edema of the small intestine wall may result in the roentgen appearance of stenosis. This finding, along with cecal deformity, ordinarily has suggested granulomatous disease.

CONCLUSIONS

1. A case is presented of apparent chronic granulomatous jejuno-ileitis which at postmortem examination five years later showed no evidence of this disease. There was, however, at postmortem examination an enterocolitis of undetermined nature. The lesion in the large intestine was classified as ulcerative colitis.

2. Chronic granulomatous disease of the small intestine until now has been considered to be characterized by stenosis. The present case indicates the possibility that resolution without stenosis might take place. The alternative explanation is a disease, possibly a variety of ulcerative colitis, in which the small intestinal lesion dominated the roentgen findings, passing through a phase of thickening and rigidity to a normal or thin small intestinal wall.

3. Two cases of granulomatous jejuno-ileitis and one of ulcerative colitis with amyloidosis are presented. It is suggested that amyloidosis in chronic enteritis is more frequent than has been suspected and might account, in part at least, for the clinical and roentgenographic findings in occasional cases of granulomatous disease.

A review of the literature also suggests the possibility that some cases considered primary amyloidosis might be instances of amyloidosis secondary to chronic enteritis.

4. Five cases are reported of extensive involvement of jejunum and ileum in ulcerative colitis. While in one case there was the possibility that the small intestinal lesions were due to shock, and another was complicated by amyloidosis, it seemed likely that at least the remaining cases represented extensions of the primary colonic disease.

5. The roentgen appearance of stenosis in the small intestine does not necessarily indicate granulomatous disease. Even in the absence of disease of the terminal ileum, ulcerative colitis cannot be excluded despite the lack of distinct roentgen evidence to indicate its presence in the large intestine. Presumably the small intestinal deformity is due to edema and infiltration without significant fibrosis.

6. These observations indicate that it is difficult to determine the type of enterocolitis from the roentgen appearance alone, and that even with postmortem data the pathogenesis may not be ascertainable.

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REPORT OF A CASE OF AN ANOMALOUS LOBE OF THE LIVER*

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THE following case is reported because of the scarcity of similar examples in the literature and because of the interesting problem in differential diagnosis which it presented.

A review of the literature revealed 2 examples of anomalous or accessory lobes of the liver derived from the right lobe and projecting upward from the diaphragmatic surface. Kornblum and Stephenson[3] reported a case of anomalous enlargement of the right lobe of the liver in a sixteen month old female infant who died of a septicemia and bronchopneumonia. During life the chest roentgenograms had shown a large dense area extending upward from the right dome of the diaphragm in a gentle curve which was interpreted to be an interlobar empyema. At autopsy an anomalous enlargement of the right lobe of the liver was found. Of incidental interest was a dissecting hematoma of the right phrenic nerve. In the discussion the authors quote Piersol as stating "one peculiar form of liver occasionally met with shows great increase of the right lobe particularly in a vertical direction with want of development of the left lobe which is thin and short." H. E. MacMahon is quoted as saying "abnormalities of the liver are uncommon," while Kaufmann's Pathology is quoted as stating "abnormal lobulation is not rare." The authors conclude that "anomalous enlargement of the liver is probably of such rare occurrence as to be of little clinical importance."

Roques and Sohier[5] report a case very similar to the one to be recorded in which a mass projecting from the diaphragmatic surface of the right lobe of the liver of a thirty year old French soldier was shown on roentgenograms following pneumoperitoneum. The lesion had been found on a routine examination and the patient was asymptomatic. The published films included only posteroanterior views which showed an orange-sized smooth mass of increased density projecting from the medial diaphragmatic surface of the liver and clearly separated from the right hemidiaphragm by a clear zone of diminished density. A diagnosis of echinococcus cyst was made and the patient was operated upon. An accessory lobe of the liver was found arising from a normal right lobe. The authors found 2 similar cases in the French literature, 1 in a female.

Chouke[2] reported an anomalous division of the right lobe of the liver without disturbance in external contour discovered at autopsy in a twenty year old female.

CASE REPORT

On July 11, 1946, a twenty-four year old aviation machinist 1/c was admitted to this hospital without symptoms because of a soft tissue mass above the right hemidiaphragm discovered on a routine roentgenogram of the chest at a separation center. He denied any serious illness in the past and had recently served on active duty in the Philippines, Palau and Saipan. A film of the chest made approximately a year before was said to have shown a similar lesion but unfortunately neither the film nor the report could be obtained.

Physical examination revealed a well nourished white male. Temperature, pulse and respirations were normal. There was slight decrease in tactile fremitus at the right costophrenic angle posteriorly and the percussion note was slightly dull in this area. No abdominal masses were palpable and there was no lymphadenopathy. The skin and genitalia were normal.

Laboratory studies included a normal red blood cell count and hemoglobin. The white

* The opinions and assertions contained herein are the private ones of the writers and are not to be construed as official or reflecting the views of the Navy Department or the naval service at large.

blood cell count and differential were normal. Urinalysis was normal. A Kahn test was negative. Examination of the stools revealed no evidence of ova or parasites. A tuberculin test was positive.

Roentgen Findings. The roentgenograms taken at the separation center were obtained and showed a smooth oval soft tissue mass about 5 cm. in greatest diameter arising from the posteromesial portion of the right hemidiaphragm and protruding into the pleural cavity. On roentgenoscopic examination there

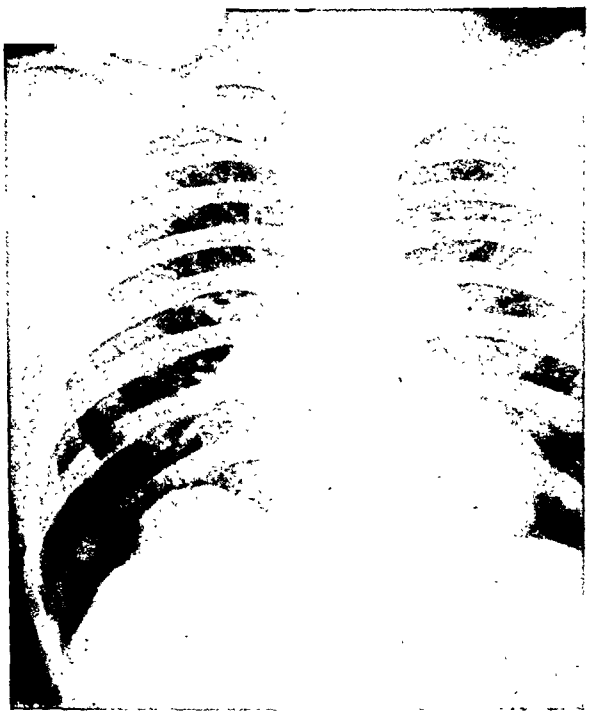


Fig. 1. Posteroanterior view of chest on admission.

was normal motion of the right hemidiaphragm in the supine and the erect positions and on quiet and forced respiration. The soft tissue mass showed no significant change in size or contour during respiration.

A roentgen examination of the upper gastrointestinal tract was negative and an intravenous urogram was normal. In an attempt to determine the origin of the mass a pneumoperitoneum was performed by Dr. James Finnerty. After 250 cc. of air had been injected into the peritoneal cavity, roentgenograms were obtained in the erect and decubitus positions. These showed clearly that the mass lay below



Fig. 2. Right lateral view of the chest on admission showing the anomalous lobe projecting upward and pushing up the right diaphragm.

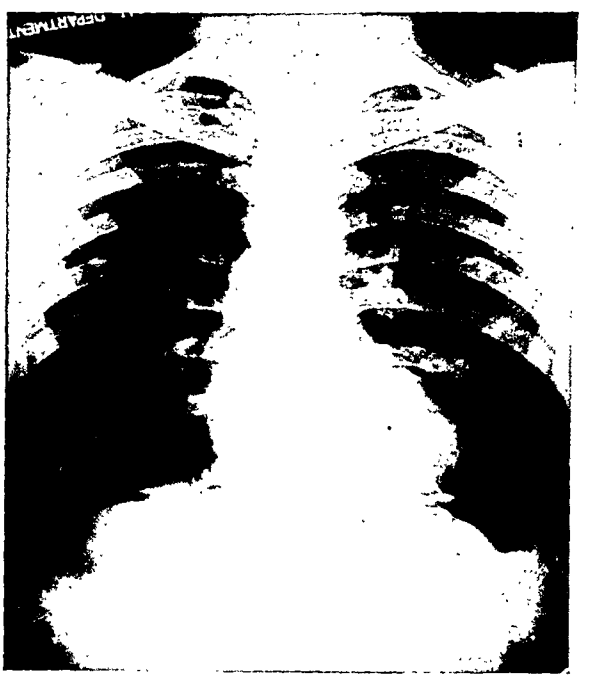


Fig. 3. Following pneumoperitoneum, the very thin diaphragm over the accessory liver lobe has been retouched to demonstrate its position.

the diaphragm and was attached to the superior surface of the liver by a broad pedicle. The portion of the right hemidiaphragm above the mass was very thin. It is worthy of note that roentgenograms obtained forty-eight hours after the pneumoperitoneum showed the lesion to even better advantage probably due to the slower rate of absorption of air around the lesion. A roentgen diagnosis of an anomalous lobe of the liver was suggested with a benign tumor of the liver to be ruled out.

In view of the latter possibility it was decided to explore the patient. While on liberty prior to operation he developed a gonococcus infection of the urethra which responded promptly to penicillin.

At operation, by one of us (E. A. K.), the pleural cavity was entered following subperiosteal resection of the right eighth rib posteriorly. A mass was found protruding into the right pleural cavity at its posteromedial portion, covered by a thinned area of the diaphragm. This was incised and a normal appearing lobe of liver was revealed. The diaphragm was sutured over the anomalous lobe and the pleura closed. The patient's postoperative course was uneventful.

Subsequent roentgenograms of the chest showed the soft tissue mass to be reduced to about one-half its previous size. The patient was discharged to active duty on November 19, 1946.



Fig. 4. Lateral view with liver and right diaphragmatic margin retouched to show air between them.

DISCUSSION

The cause of anomalous lobes of the liver is unknown. At one time tight-fitting corsets were thought to be capable of producing lobulation of the liver but this is no longer considered to be a factor. Chouke[2] states that the lobes of the liver grow along the course of the different embryonic veins and that anomalous lobes may be the result of an extra branch of a vein.

The importance of pneumoperitoneum in establishing the location of the lesion in the liver is noteworthy. Stewart and Stein[6] describe the technique of pneumoperitoneum and Carelli[1] published many illustrations of roentgenograms following pneumoperitoneum including several examples of echinococcus cysts of the liver. Pendergrass[4] has recently reviewed the diagnosis of lesions adjacent to the diaphragm and

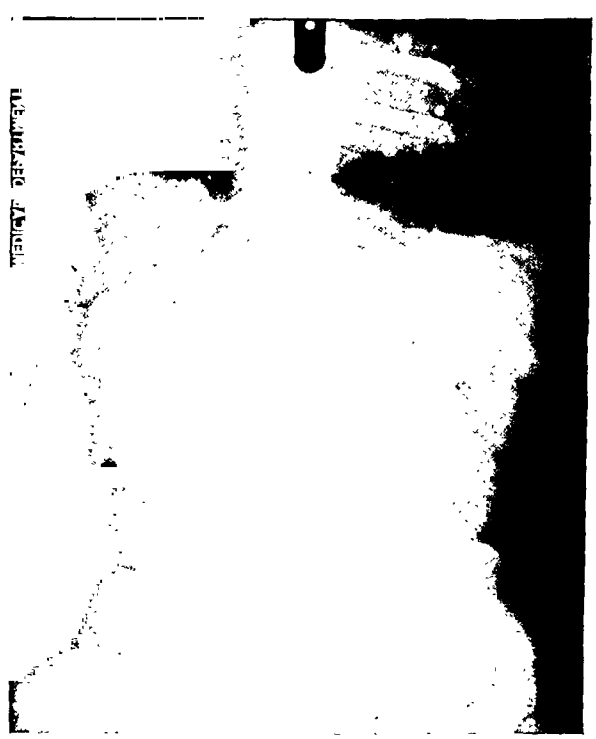


Fig. 5. View of the upper abdomen made two days after pneumoperitoneum was instituted. The retouched line represents the diaphragm into which the projecting pedunculated accessory lobe of the liver almost completely surrounded by air is demonstrated.



FIG. 6. Right lateral view of the chest following operation, at which time the diaphragm was plicated and sutured over the lobe.

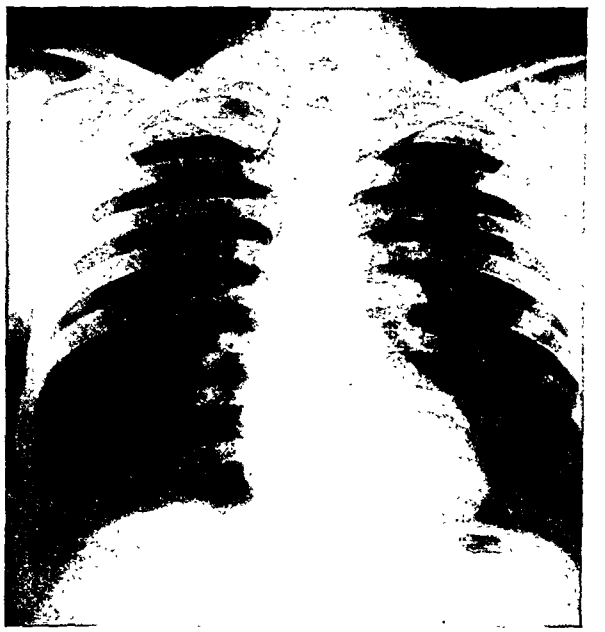


FIG. 7. Posteroanterior view of the chest following operation.

emphasized the importance of pneumoperitoneum.

In the differential diagnosis of such a lesion, the history and physical and laboratory findings are of paramount importance. Gummas should be associated with a positive serologic test for syphilis and clinical evidence of syphilis. Inflammatory lesions should be accompanied by a history of a febrile illness. Echinococcus cysts may be multiple and should be suspected in the presence of a positive complement fixation test and occasionally an eosinophilia. Malignant tumors should increase in size within a reasonable follow-up period. Benign tumors remain difficult to differentiate. Pneumoperitoneum remains the fundamental procedure to differentiate between a lesion of the diaphragm itself and a lesion of the liver. Now that mass roentgenography of the chest is popular it is reasonable to assume that congenital anomalies of this type will be recognized with increasing frequency.

SUMMARY

A case of an anomalous lobe of the liver producing a soft tissue density above the right hemidiaphragm has been presented in which the correct diagnosis was suggested by the roentgen examination, particularly with pneumoperitoneum, and confirmed by operation. Two somewhat similar cases in the literature have been reviewed.

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LEGG-PERTHES' DISEASE: A SYNDROME OF MANY ETIOLOGIES?

WITH CLINICAL AND ROENTGENOGRAPHIC FINDINGS IN A CASE OF GAUCHER'S DISEASE

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THE demonstration of changes in the hips which are characteristic of so-called Legg-Perthes' disease in a patient with a previously established diagnosis of Gaucher's disease, has recently led us to a study of the literature pertinent to both conditions. We found a singular lack of appreciation of the relationship which may and can exist between these two disorders.

From our study, it furthermore evolved that Legg-Perthes' disease is very often not a definite clinical entity, but rather a syndrome of many etiologies. The characteristic roentgenologic picture may be found in a great variety of disorders (symptomatic type). In probably only a relatively small number of instances, the etiology may remain obscure (idiopathic type). Legg-Perthes' disease is, therefore, not in itself a sufficiently satisfactory diagnosis.

According to this concept, the roentgenographic demonstration of a flattened femoral head with a short, wide neck, with or without coxa vara, should always be the starting point for further combined roentgenologic and clinical investigation in an attempt to discover the underlying pathogenic factors. Early recognition of the etiologic mechanism involved is important from both the prognostic and therapeutic standpoints.

REPORT OF CASE

First admission (May, 1929). B.G., a white female Jewish child, aged five, was admitted to the Michael Reese Hospital for study. The mother stated that she had noticed increasing pallor, progressive enlargement of the child's abdomen, and occasional nosebleeds over a period of one year. Four days prior to admission, gross hematuria was observed. Past and family history were non-contributory. Physical examination revealed a well developed but undernourished patient. There was conspicuous pallor, and petechiae were present on the buccal mucosa. Large, non-tender cervical, smaller axillary, and inguinal lymph nodes were present bilaterally. The abdomen was distended and a large spleen was felt extending downward to the iliac crest. The liver was palpable two and one-half fingers below the costal margin. The extremities were freely movable and showed symmetrical brownish pigmentation of the skin over both tibiae. Temperature was 103° F. Examination of the blood showed: hemoglobin 50 per cent (Sahli), red cell count 2.02 million, white cell count 3,050 with 57 per cent polymorphonuclear neutrophils and 43 per cent lymphocytes. Platelets numbered 10,000. The hypotonic saline fragility of the red blood cells was within normal limits. The Kahn test was negative. Urinalysis showed 2 plus albumin with few granular casts and leukocytes, but no red blood corpuscles were present in the sediment. Roentgenograms of the skull and long bones disclosed no pathology.

Five weeks later, a splenic puncture showed typical Gaucher cells. Splenectomy was then performed in order to combat the bleeding tendency. The spleen weighed 570 grams. Histopathologically, typical Gaucher cells were found. The postoperative convalescence was uneventful and the child was discharged to be followed in the outpatient department.

The patient was thereafter admitted to the hospital on numerous occasions over a period of eighteen years. In order to save space, the essential findings are summarized in Table 1.

In 1945, the patient married and in December, 1946, she became pregnant. She felt very well, weighed 110 pounds and walked straight and without much limp. Blood examination:

* The Department of Hematologic Research is supported by the Hematology Research Foundation and the Michael Reese Research Foundation.

TABLE I

SUMMARY OF SIGNIFICANT FINDINGS

Admission	Clinical Findings	Hematologic Findings	Roentgen Findings	Remarks
1st admission May, 1929	Increasing pallor, progressive enlargement of abdomen, nosebleeds, gross hematuria, petechiae, lymphadenopathy, hepatosplenomegaly	Hb 50% (Sahli), RBC 2.02, WBC 3,050 (57% polys, 43% lymph), platelets 10,000. Splenic puncture: typical Gaucher cells	Skull and long bones: no pathology	Splenectomy
2nd admission 18 mo. later	Pain in left thigh with limp and difficulty in walking. Temp. 102° F. Left thigh held flexed, abducted and externally rotated. Tenderness over distal end of femur	Hb 80%, WBC 33,650 (88% polys, 12% lymph.), platelets 140,000	Left femur and knee: no signs of osteomyelitis; 1 month later: periosteal elevation and proliferation with rarefaction of femur	Diagnosis "acute osteomyelitis of left femur." A hole drilled through femur and a small bone fragment removed exposing the marrow cavity; small amount of "pus" found. Path. exam.: bone necrosis. Culture of "pus": only air contaminants
3rd admission Feb., 1931	Pain in right leg apparently following a fall. Temp. 104° F. Epistaxis. Slight tenderness at right knee joint but not along femur	Hb 60%, RBC 2.63, WBC 14,000, platelets 170,000, bleeding time 2 min. Smear: occasional normoblasts	Long bones and spine: no abnormality	
3 mo. later			Changes in both femoral heads and necks involving especially the intertrochanteric region. Impression: hypertrophic osteitis	
4th admission June, 1931	Difficulty in walking. No tenderness over any of the bones or joints. Right leg 1.5 cm. shorter than left leg	Hb 65%, RBC 3.19, WBC 15,350, platelets 270,000	Rarefaction and sclerosis in neck of right femur	Bilateral abduction with traction to correct the coxa vara deformity
5th admission March, 1932	Severe pains in left shoulder		Roentgenograms of left humerus after surgery showed changes in bone texture in entire shaft, but no periosteal reaction	On day of admission operation performed because of diagnosis "acute osteomyelitis of left humerus"; no pus found
1934			Marked [illegible] tion of right [illegible] destruction [illegible] on left side to a lesser degree. Impression: bilateral Perthes' disease	
6th admission Oct., 1937	Generalized aches and pains and temp. of 104° F. Liver palpable 3 fingers below costal margin	Hb 70%, RBC 4.13, WBC 32,900 (59% polys, 32% lymph, 9% mono.), platelets 320,000, bleeding time normal. Tourniquet test negative. Sternal puncture: bone marrow infiltration with typical Gaucher cells	Decrease in density of bones of thoracic spine and coarsening of bony texture. Pelvis: bilateral coxa vara Right femoral head appeared to have slipped downward and laterally. Metaphyseal zone of neck decreased in density and mottled. Shaft contained many radiolucent cyst-like rarefactions. Left capital epiphysis flattened and changes in the metaphyseal zone as well as cyst-like rarefaction similar to those seen in shaft of right femur present. Lower femur showed typical Erlenmeyer flask deformity	
7th admission June, 1938	[illegible] ocal mo-		Shoulder joint negative; humerus showed several well circumscribed pea-sized radiolucent areas in its midportion. Pelvis (Fig. 1): flattening of heads of femurs with widening and [illegible] areas arthr [illegible] joint	
8th admission June, 1939	Intermittent pain in right thigh gradually increasing in severity	Hb 60%, RBC 3.38, WBC 17,400 (39% polys, 61% lymph)	Pelvis: intermingled areas of osteoporosis and condensation with excavation of medullary canals of upper femurs and coxa vara deformities. Capital femoral epiphyses had slipped, heads mushroomed in appearance	
Aug., 1940			Pelvis (Fig. 2): progressive changes in left sacroiliac joint. No appreciable changes in remainder of pelvis and hips in comparison with examination of June, 1938	

hemoglobin, 64 per cent; red blood cell count, 3.27 million; white blood cell count, 16,700. Nucleated red cells and Howell-Jolly bodies were present. The liver was enlarged three fingers below the costal margin, but the lymph nodes were not palpable. In March, 1947, the blood showed hemoglobin 72 per cent, red blood cells 3.70 million, white blood cells 9,650, platelets 164,000. Differential count: segmented neutrophils 54 per cent, non-segmented neutrophils 18 per cent, lymphocytes 20 per cent, eosinophils 1 per cent, monocytes 4 per cent,

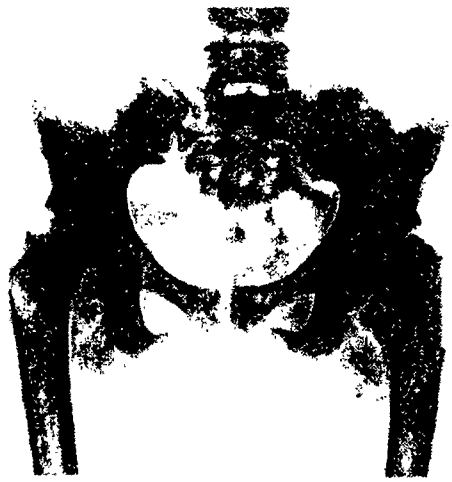


Fig. 1. June 23, 1938. Note the early arthritic changes in the left sacroiliac joint. The femoral heads are flattened and the necks shortened and widened. There is a bilateral coxa vara. Multiple mottled areas of decalcification are present in the upper femoral shafts. The findings are consistent with a diagnosis of Legg-Perthes' disease.

metamyelocytes 3 per cent. Nucleated red cells, Howell-Jolly bodies and target cells were present.

A roentgenogram of the pelvis (Fig. 3) demonstrated bilateral flattening of the femoral heads, rather severe coxa vara, and areas of radiolucency and sclerosis of the femoral heads, necks, and proximal shafts. The iliac portions of the acetabular fossae also showed signs of



Fig. 2. August 15, 1940. Note the progressive changes in the left sacroiliac joint. There is now early bony fusion. Otherwise, there is very little appreciable change since the last examination on June 23, 1938.

radiolucency and sclerosis. Arthritic changes were present bilaterally. The left sacroiliac joint was markedly sclerotic and almost completely obliterated. Minimal hypertrophic spurring was present in the lower lumbar vertebrae. The lower ends of the femurs (Fig. 4) showed the typical Erlenmeyer flask appearance with a widening of the medullary cavities, thinning of the cortices and numerous areas of radiolucency in the shafts. As an incidental finding, there were discovered some arthritic changes in



Fig. 3. March 13, 1947. Roentgenogram of the pelvis shows severe advanced arthritis in the left sacroiliac joint and also in the lower lumbar spine. Severe articular and juxta-articular changes are present in both hip joints with a semilunar defect in the lateral margin of the left femoral head. The femoral shafts are greatly widened and the cortices are very thin and irregular.

the left knee joint with calcification of the medial meniscus. In the mandible (Fig. 5) were found typical areas of unilocular osteoporosis and apparent disturbance of trabecular structure, as described by Levine and Solis-Cohen.[24]

COMMENT

This patient represents a case of Gaucher's disease which manifested itself at the early age of five with hepatosplenomegaly and symptomatic thrombocytopenic purpura. Splenectomy permanently relieved the patient of the purpura. Further study over a period of eighteen years showed the continued presence of a moderate normochromic normocytic anemia due to bone

marrow infiltration by Gaucher cells, moderate hepatomegaly and the sequelae of splenectomy, e.g., leukocytosis, appearance of nucleated red blood cells, Howell-Jolly bodies and many target cells. These hematologic changes are typical for the post-splenectomy patient as has been shown by Singer, Miller and Dameshek.[38] However, only the involvement of the osseous system was of real significance for the well-being of this particular patient.

As can be seen from the roentgenograms (Fig. 1, 2 and 3), there are present marked bilateral coxa vara, mushrooming of the femoral heads, widening and shortening of the femoral necks and radiolucent defects scattered throughout the femoral shafts. The Erlenmeyer flask appearance of the lower femurs is clearly shown in Figure 4, as well as some arthritic changes in the left knee. The lytic lesions in the mandibles may be seen in Figure 5. The associated changes in the lumbar spine, sacroiliac and lumbosacral joints may be noted in Figure 3, as well as a defect in the lateral margin of the left femoral head which probably represents the result of a rather severe destructive arthritic process.

Given any one of the roentgenograms of the pelvis as a single examination, and disregarding the history of Gaucher's disease, and perhaps the radiolucent shadows in the femoral shafts, the roentgenologic diagnosis could reasonably be Legg-Perthes' disease. All of the necessary criteria are present. As will be pointed out in the general discussion, however, such a diagnosis is probably incomplete in any case which presents such roentgen findings. Certainly in our case, it is essential to the total diagnosis that the patient is suffering from Gaucher's disease.

Our patient was twice subjected to surgery, both times for "acute osteomyelitis" and both times on the day of admission. In each instance, the diagnosis was made clinically and roentgenograms were taken immediately after the surgery. Actually, no osteomyelitis was present on either occasion. This is a rather typical occurrence,



Fig. 4. March 20, 1947. Lower femurs: Marked "Erlenmeyer flask" appearance of both lower femoral shafts, characteristic of Gaucher's disease. There is also calcification in what is probably the left medial meniscus and early arthritic change in the joint.

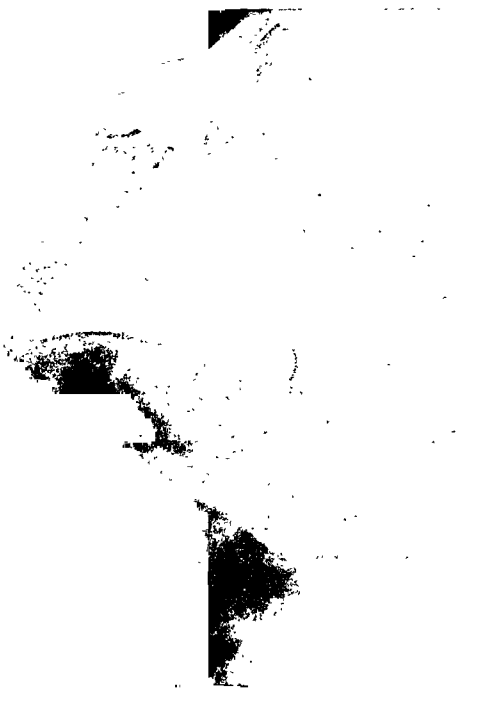


Fig. 5. March 20, 1947. Left mandible: Distinct osteoporosis of the mandible with apparent disruption of trabecular structure, probably the result of invasion by Gaucher cells. Examination suggested by the case of Levine and Solis-Cohen.[24]

as will be discussed later, and it demonstrates the need for universal appreciation of the clinical findings produced by the "bone crises" of Gaucher's disease.

DISCUSSION

Although so-called Legg-Perthes' disease has been recognized for only a relatively short period of time, the literature concerning this syndrome is quite extensive. The disease was first described by Legg[22] and independently by Waldenström[42] in 1909. In 1910, Calvé[7] and Perthes[30] described the same condition. It was not until 1913, however, that Perthes[31] first offered a clear-cut description of the clinical course and the roentgenographic findings. Since then, further additions to the literature have consisted mostly of attempts to arrive at a uniform concept of the etiology and pathology of the disease.

Because of the diversity of opinion as to the actual disease process, there has been introduced into the literature a number of names for the condition, none of which seems to be wholly satisfactory or adequate to explain its occurrence. The most familiar of these terms is probably Legg-Perthes' disease, sometimes Legg-Calvé-Perthes' disease and sometimes even Legg-Waldenström-Calvé-Perthes' disease. Then there are osteochondritis juvenilis deformans, quiet disease of the hip, pseudocoxalgia, and osteochondrosis, to name but a few. Because of this great variety in terminology and the universally disliked use of proper names applied to diseases, Waldenström,[42] in 1938, suggested the term coxa plana. Valid objections may be raised with respect to the latter term as well, inasmuch as not all cases progress to this end stage of the active disease process.[39] Several authors have been able to show variable degrees of involvement, apparently dependent on the proper and early institution of therapy. Furthermore, Gill[14] believes that the primary location of the disease is in the metaphysis of the femoral neck rather than in the capital epiphysis as postulated by Waldenström.[42]

There is also no unanimity of opinion with respect to the etiology. Brailsford[5] lists the following theories of causation and some of their principal advocates. We have modified and brought this list up to date.

1. Traumatic: Legg,[22] Goldenberg,[16] Pich.[32]
2. Infection or inflammation: McWhorter.[28]
3. Congenital stigmata: Jansen,[18] Müller.[27]
4. Unrecognized congenital dislocation of the hip: Calot.[6]
5. Rickets: Calvé.[7]
6. Rheumatic: Perthes.[31]
7. Endocrine disorders: Cavanaugh, Shelton and Sutherland,[9] Albright.[1]
8. Embolic: Axhausen.[3]
9. Vascular: Bentzon,[4] Zemansky and Lippman,[44] Leriche and Policard.[23]
10. Familial: Kehls.[20]
11. Osteochrondritis similar to Köhler's disease: Brailsford.[5]
12. Alterations in calcium-phosphorus metabolism: mentioned by Cavanaugh, *et al.*[9]
13. Syndrome of many etiologies.

Brailsford presents evidence from his own work and that of others to show that the familial theory is inadequate, that the concept of congenital stigmata is incorrect, that the theory of endocrine imbalance does not explain the incidence in endocrinologically normal individuals. Furthermore, he shows that there is no evidence of either an osteitis or a chondritis to support the infectious theory, that rickets and congenital dislocation of the hip do not apply in a sufficient number of instances. Therefore, none of the theories are completely satisfactory although trauma is the one factor demonstrable in the majority of the cases. Even this explanation is not, by itself, entirely adequate and the concepts of vascular and neurotrophic alterations must also be invoked to complete the requirements of disease causation.

Thus the problem of the etiology of so-called Legg-Perthes' disease remains unsolved. The mere fact that it has been necessary to suggest such diverse factors as endocrine imbalance as opposed to localized infection indicates a lack of real under-

standing of the actual pathogenesis of the disease. According to Gill,[15] it is doubtful that all types of osteochondritis juvenilis are manifestations of the same pathologic process and and due to one and the same cause. In further support of this concept, we suggest the addition of Gaucher's disease to the list of causative factors.

There are numerous reports of the incidence of bone changes in Gaucher's disease. There have even been specific references to the production of changes similar to Legg-Perthes' syndrome, but the relationship is not too well recognized probably because of the relative rarity of this combination. In discussion of Gaucher's disease in the accepted textbooks of roentgen diagnosis, only Archer,[2] citing the case of Reiss and Kato,[36] states that "often there is flattening of the head similar to that in Legg-Perthes' disease."

Ferguson,[12] in his discussion of coxa plana, includes the roentgenograms of 2 cases in which there are marked changes in the femoral heads and necks. Both cases were proved by splenectomy to be instances of Gaucher's disease. From the reproductions, one gets the distinct impression that without the diagnosis of Gaucher's disease having been established, primary consideration would have to be given to Legg-Perthes' disease. Thannhauser[41] confesses just such a reaction on studying the roentgenograms of one of his own cases. Hodges, Phemister and Brunschwig[17] describe a case of Gaucher's disease which shows beginning collapse of the right femoral head. These authors do not state, however, that this is an instance of Legg-Perthes' syndrome produced by Gaucher's disease. The reproductions lead us to believe that such a conclusion might be valid.

One of the cases of Cushing and Stout[10] was thought to have a neurotrophic joint and, after splenectomy, was subjected to a resection of the femoral head and neck. The marrow, however, was almost entirely replaced by Gaucher cells. Santee[37] reports a patient who was treated for tuberculosis of the hip joint. The diagnosis of Gaucher's disease was established by splenectomy. Welt, Rosenthal and Oppenheimer[43] discuss the incidence of bone changes in Gaucher's disease. An analysis of their reproductions shows 3 cases out of 8 in which there is mushrooming of the femoral head and shortening of the femoral neck. The deformity was not thought to be a primary local one but a secondary static effect due to a relatively increased load borne by the diseased bone. Milch and Pomeranz[26] in 1 of their cases show distinct involvement of both capital femoral epiphyses as well as several other bones in the body. They point out that the condition is often mistaken for acute osteomyelitis or tuberculosis of the hip joint by the clinician.

Kirklin and Hefke,[21] reviewing the literature on osseous Gaucher's disease, found 13 cases, including 1 of their own, which showed changes in the femoral head or pelvis. Most of their cases were thought to be analogous to tuberculosis of the hip. Reiss and Kato[36] are the first (1932) to state definitely that the end picture of Legg-Perthes' syndrome may be simulated by Gaucher's disease. In the same year, Determann[11] also described a case in which the changes in the left hip joint suggested a residuum of Perthes' disease rather than of Gaucher's disease. Melamed and Chester[25] present a case which is probably the most severely involved skeletal Gaucher's disease reported. The principal involvement is in the vertebral column, but close examination of the left femoral head reveals some changes which are very suggestive of Legg-Perthes' disease. Perlman[29] describes a case in which the roentgenologist first thought that the irregular mottled density seen in the right femur was due to a long standing osteomyelitis. There is also, however, apparent shortening and widening of the neck of the femur and a marked coxa vara. These findings, if the clinical history of Gaucher's disease could be disregarded, could very easily fit the criteria for a diagnosis of Legg-Perthes' disease.

From the review of the literature and our

own observation, it seems apparent that so-called Legg-Perthes' disease may occur as either a symptomatic or an idiopathic type. When the roentgenographic examination reveals this condition, a thorough search for the etiologic mechanism should always be made. Whether such diverse causative factors as discussed above have some common denominator leading to the same end result is unknown but seems quite plausible. The final answer must come from pathological studies. Unfortunately, such material is relatively rare and the interpretation and synthesis difficult. And yet, until such an intensive histopathologic study is performed, one can only postulate that perhaps some such common factor does apply for this great variety of pathogenic mechanisms acting at the same site. It is the purpose of this paper to emphasize the concept of the symptomatic type of Legg-Perthes' disease, and to demonstrate that in addition to the already suggested causative factors, Gaucher's disease should also be taken into consideration. The number of cases which may fall into the idiopathic group can only be determined by further detailed investigation.

The surgical interventions for supposed acute osteomyelitis performed in our case, and also frequently reported in the literature,[8,10,12,26,35,43] warrant some comment. That the clinical picture of acute osteomyelitis may be simulated by Gaucher's disease should be stressed in order to prevent unnecessary operations.[13,26,33,40] Careful clinical and roentgenological studies will further serve to eliminate this hazard.

SUMMARY

1. A case of proved Gaucher's disease exhibiting the roentgenographic features of Legg-Perthes' disease is presented.

2. A review of the literature demonstrates that so-called Legg-Perthes' disease is often not a distinct disease entity. It may occur as either a symptomatic or an idiopathic manifestation. Such diverse factors as trauma, infection, endocrine dysfunction, vascular accidents, and so forth, have to be considered as etiologic agents. Demonstration of the features of Legg-Perthes' disease should lead to an attempt to uncover the underlying etiology. Only further detailed investigation will disclose the actual number of cases falling into the idiopathic group.

3. Gaucher's disease should be added as a possible causative mechanism. The simultaneous occurrence of Gaucher's disease and Legg-Perthes' syndrome seems to be sufficiently frequent to exclude a coincidental relationship.*

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* A normal 5 pound, 1 ounce boy was born to the patient on July 31, 1947. When last seen, mother and child were well.

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TRAUMATIC INSTABILITY OF THE ANKLE JOINT

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THE term traumatic instability of the ankle is suggested to denote the clinical picture resulting from a partial or complete tear of the lateral ligaments of the ankle joint. During the past years several excellent articles have been written concerning diagnosis and treatment of injuries to the lateral ligaments of the ankle joint. However, in my experience it is found that this condition is still not readily recognized.

The primary purpose of this paper is to strongly emphasize the importance of a special roentgen technique to be followed routinely in cases of sprained ankles. Eleven cases have been seen in the past fourteen months. Three were severe enough to warrant surgical repair. Five were diagnosed at the time or shortly after injury and conservative treatment was helpful. Three of the patients, in the mildly chronic group have responded to conservative treatment and are symptom free at the time of this report. These cases were diagnosed by the roentgen technique to be described.

From this experience it is felt that the term "ankle sprain or foot sprain" should be discarded unless special roentgen technique has ruled out a ligamentous tear.

HISTORY

In acute cases, the patient usually described an inversion (supination) injury of greater or lesser degree. The trauma described in some cases could be classified as minor. Therefore, a relatively simple injury does not necessarily exclude the possibility of a ligamentous tear.

In chronic cases, the complaint was of instability of the ankle with pain of varying degrees. The slightest roughness of the ground or an uneven curbstone caused the patient's ankle to turn sharply and suddenly into inversion. From occasional episodes of accidental inversion to extreme disability with constant pain due to traumatic arthritis, there are many stages in which the patient may seek the advise of a physician. In taking the history it is important to inquire whether or not this is the first episode or the most recent of a series of minor traumas.

ANATOMY

The ligaments to be considered in this injury are the ones binding the fibula, astragalus and calcaneus together. However, in severe cases the ligaments between the talus and scaphoid and the calcaneus and cuboid respectively may be involved.

The external ligaments of the ankle consist mainly of fasciculi of the capsule which appear to be distinctly separated into three portions.

1. Anterior fasciculus or ligamentum talofibulare anterius, with almost transverse fibers.

2. The posterior fasciculus or ligamentum talofibulare posterius, the most deeply seated of the three, these fibers are almost horizontal.

3. The middle fasciculus or ligamentum calcaneofibulare which is the longest and strongest of the three.

There are a number of other ligaments; lateral talocalcanean ligament, interosseus talocalcanean ligament, which may be involved in an extensive tear. The bifurcated ligament between calcaneus and scaphoid, calcaneus and cuboid as well as the dorsal talonavicular ligament have to be considered.

FUNCTIONAL ANATOMY AND MECHANISM OF INJURY

Contrary to one observer's findings, the author has noted that in a normal ankle the relationship of the talus to the tibia and fibula in the ankle mortice is absolutely stable. In other words, the upper surface of the talus and the distal surface

of the tibia form a joint space the width of which is equal at all times whether in neutral position, inversion or eversion. There is no lateral or medial tilt of the talus under normal conditions, providing the foot is kept within the normal degree of dorsiflexion. Roentgen studies were made of 25 normal ankles, 15 of which were injected with procaine, in the manner described in this article, and no degree of tilt was detected.

It should be stressed that in cases with only a minimal defect noted in the roentgenogram (minor tilt of the talus) there were disabling symptoms, necessitating in 2 cases surgical intervention. This observation appears to disagree with the findings of Watson-Jones.

There is, however, an unstable position which the ankle can assume and it is in this position that the injury occurs, that is plantar flexion. The reason is that in this position the talus, which is wedge-shaped, is being controlled only loosely by the malleoli and a slight degree of inversion and eversion is possible. Therefore, it is reasonable to assume that if a roentgenogram is taken in inversion and plantar flexion, a tilt can be produced; however, it seldom exceeds 4 or 5 degrees. And it follows that the female patient who wears high heels, thus maintaining the foot in plantar flexion has frequent inversion and eversion episodes producing serious ligamentous tears.

ROENTGEN TECHNIQUE SUGGESTED AS A ROUTINE

Since the consequences are so disabling every single inversion injury of the ankle should be roentgenographed in the following manner;

(a) A routine anteroposterior, lateral and oblique exposure.

(b) One anteroposterior view with the forefoot held in extreme inversion. This motion is usually restricted by severe pain.

(c) Five to ten cubic centimeters of 2 per cent procaine hydrochloride solution are injected at the site indicated in Figure 2, *A*, *B*, *C*. It is injected into the sinus tarsi which is about 1¼ to 1½ inches distal in a horizontal line extending from the lower tip of the fibula. However, when the area is swollen it is not always easy to palpate the lower tip of the fibula but with the aid of the aforementioned landmarks, some of which are palpable and others may be visualized on the roentgenograms, the injecting needle falls easily into the sinus tarsi. Ten minutes later the maximal painless inversion can be obtained, and another view should be taken in this position.



Fig. 1. Represents one of the 25 normal ankles. This patient received a local anesthetic and roentgenograms were taken in the maximal inversion. The film does not show any change in the position of the talus.

In 3 cases of the series, there was only a minimal separation of the mortice with the first view taken in inversion but after the anesthetic there was a definite gap visualized.

TREATMENT

Aside from the diagnostic value, the procaine injection has a definite therapeutic effect. It is well known that procaine injections are widely used in the treatment of ankle sprains. If the roentgenogram is negative, repeated procaine injections will

hasten the patient's recovery. If, on the other hand, there is a separation of the mortice, and the case is an acute one, the method of choice is immobilization in plaster of paris for eight to twelve weeks. In chronic cases, the real instability or recurrent dislocation should be treated by surgery.

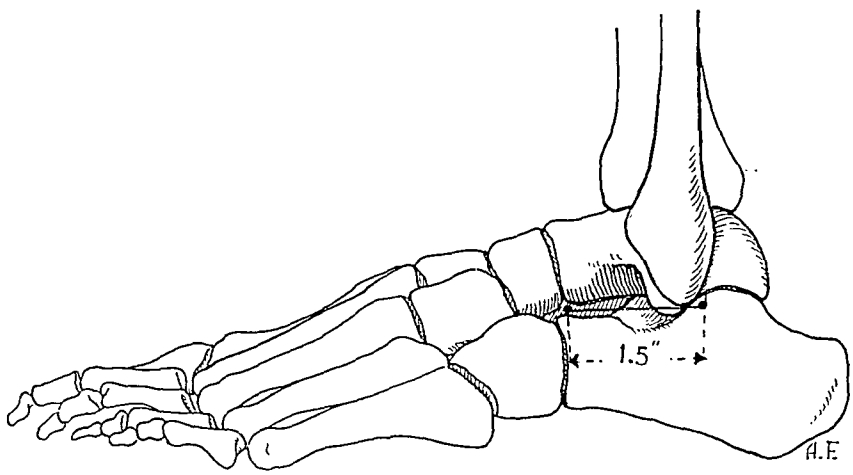


Fig. 2*A*. Sketch showing the bony landmarks of the left ankle, in the lateral position. The location of the sinus tarsi is indicated. The distance from the posteroinferior edge of the fibular malleolus is about 1¼ to 1½ inches. Five to ten cubic centimeters of 2 per cent procaine injected into the sinus tarsi will infiltrate the structure so that sufficient relaxation is obtained to permit extreme inversion.

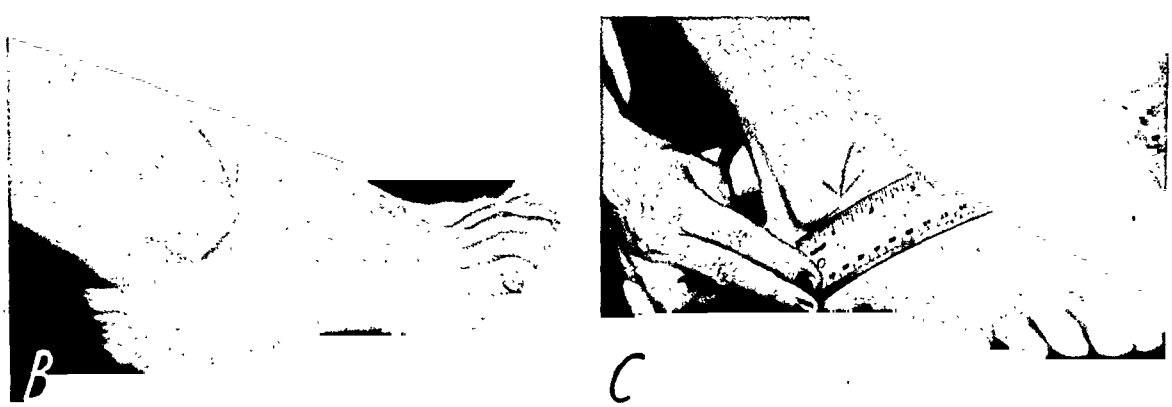


Fig. 2, *B* and *C*. Photographs indicating the exact site of injection. This applies to chronic or late cases; in the acute stage the site of the hematoma is injected.

CASE REPORTS

Case 1. W.S., an athletic director, aged twenty-four, injured his right ankle in November, 1946, while playing soccer. He had negative roentgen reports and was treated for a sprain without definite relief. He was first seen on June 25, 1947, when special roentgenograms revealed an inversion instability of the talus (Fig. 3). At the close of the school term on August 25, 1947, the patient was operated upon for repair of the lateral collateral ligament of the right ankle. The pain and instability disappeared. Follow-up in March, 1947, revealed no complaints.

Case 11. P.C. A male, jeweler, aged twenty-six, on August 29, 1947, while running, twisted his right ankle. Roentgenograms were reported negative and he was treated for a sprain. After six months of "lamp" treatments the ankle continued to feel "weak" and to become swollen at intervals. Examination on February 24, 1948, revealed pain with the extremes of motion, especially inversion. Roentgenograms, using special technique, revealed a displacement of the

talus. Operation was performed for repair of the lateral collateral ligament (Fig. 4).

Case III. R.F., aged fifty-one, assistant principal of a high school, stepped off an icy curb, twisting her ankle. Roentgenograms, using special technique taken within a matter of hours, revealed a displacement of the talus without the use of anesthetic. Immediate immobilization for six weeks in plaster of paris boot resulted in complete recovery. Follow-up in



Fig. 3. Case I.

fourteen months revealed no clinical objective or subjective symptoms (Fig. 5).

Case IV. H. G., a housewife, aged forty-five, was seen at the New York Polyclinic Hospital. She gave the usual story of numerous episodes of painful inversion of the ankle without definite accident, but attributed by the patient to "weakness." The duration of these complaints was fourteen months. Figure 6*A*, taken without anesthetic, shows a suggestion of a tilt; however, Figure 6*B*, using the technique described, shows an extensive tilt.

DISCUSSION

Changes in the ankle mortice, following one or more inversion injuries, do not have to be very extensive in order to cause severe disabilities. The diagnosis of "ankle sprain"

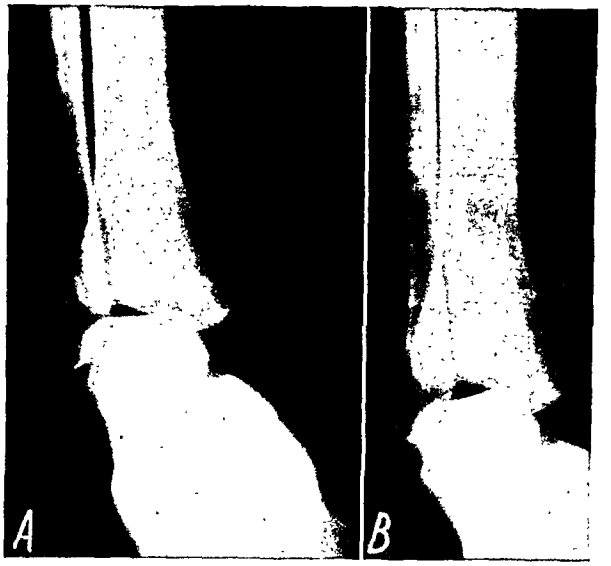


Fig. 4, *A* and *B*. Case II.

in the minds of many observers is a very abused term. However, it is the indiscriminate treatment of injuries in this group that appears to be responsible for the subsequent incapacitating changes that take place. If a routine roentgen technique, as suggested, is applied, this injury can be diagnosed immediately and efficiently. And it follows without a doubt that early adequate treatment consisting of prolonged immobilization in a plaster of paris boot will result in



Fig. 5. Case III.

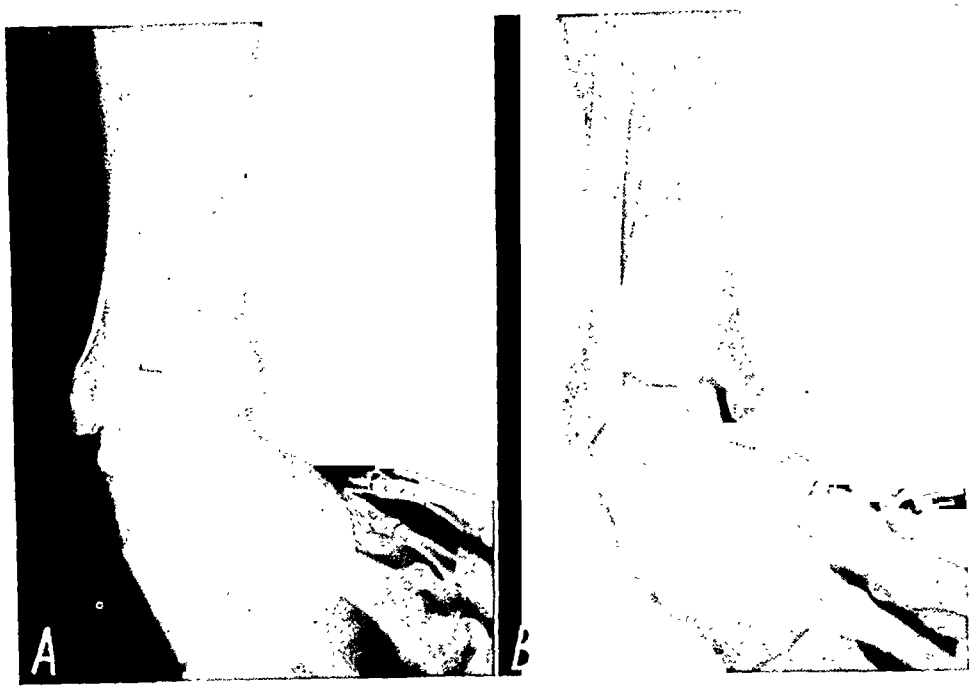


Fig. 6, *A* and *B*. Case IV.

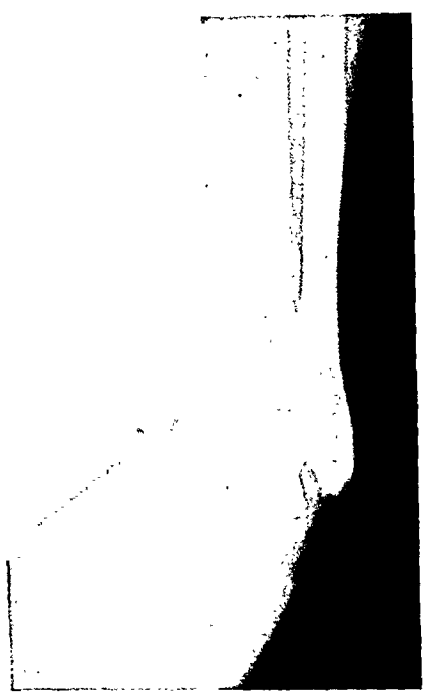


Fig. 7. An acute injury with negative roentgen reports. This illustration is a simple inversion view without anesthetic, which shows sufficient injury to warrant the roentgen diagnosis of torn ligament with subluxation of the astragalus.

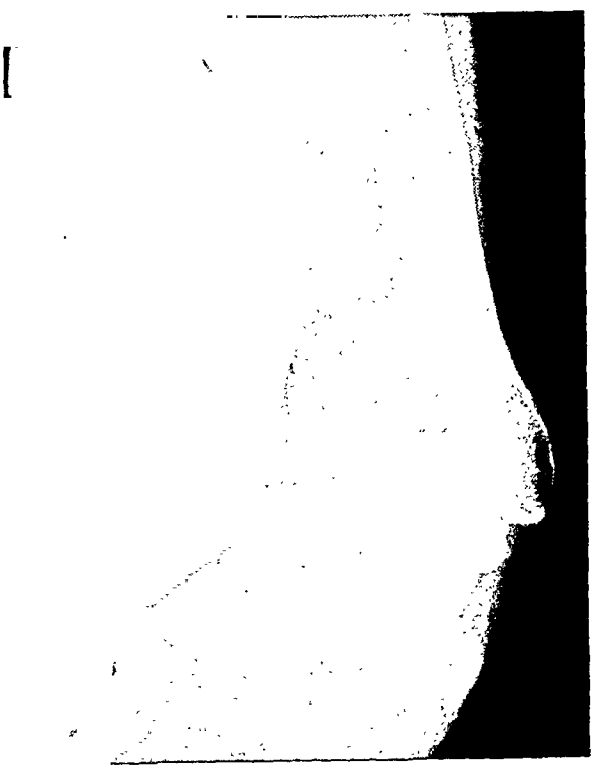


Fig. 8. An acute injury with the usual negative roentgen report. Inversion view following administration of anesthetic revealed the pathology.



FIG. 9. A borderline case. There are minimal changes seen in extreme inversion following local anesthetic. Patient had complaints of chronic instability. The roentgenogram also shows the correct way to hold the foot for this exposure.*



FIG. 10. This patient "sprained" her ankle eighteen months prior to this roentgen examination. She has been under treatment for that period and never had a roentgenogram taken.

a complete recovery in practically all cases. If the acute stage is not recognized the importance of this roentgen technique in diagnosing the chronic condition is very evident. Operative treatment as suggested by Watson-Jones and the various modifications of this procedure offer very satisfactory results.

CONCLUSIONS

1. Minimal changes about the ligamentous structures of the ankle joint, medial as well as lateral, cause disabling complaints.

2. The diagnosis of sprain is too readily applied to injuries of the ankle.

3. Roentgenograms with the technique described simplify the method of making a diagnosis of a tear of the lateral collateral ligament of the ankle joint.

4. Early and accurate diagnosis of minimal as well as extensive changes in the ligamentous structures of the ankle joint insures the possibility of a good end result.

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* The technician's hand is shown here without protection in order to better illustrate the position in which the foot should be held.

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KIDNEY STUDIES DURING CHOLECYSTOGRAPHY WITH PRIODAX*

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THE use of the organic compound, priodax, for oral cholecystography has become widespread in roentgenology. Numerous clinical reports have attested to its reliability.[1,2,4,6,7] According to these investigators, one of its recommendations is the fact that it is largely excreted through the kidneys, so that confusing shadows of dye in the colon no longer interfere with roentgen interpretation. Although Rigler and Mixer[8] have demonstrated that diodrast injected through a T tube during cholangiography may pass through the liver and be seen in the kidneys, there seem to be only two references in the English literature to the possibility of obtaining accessory information concerning the kidneys during a routine gallbladder examination. Hefke[5] mentions the fact that a priodax cholecystogram of one of his patients demonstrated a hydronephrosis which had not been suspected clinically, and the same observation has been made by Sosman.[9] Because of a similar experience in our clinic (Fig. 1), we began to look for shadows of the dye in renal structures in every cholecystogram in which priodax was used, and it soon became apparent that such shadows were visible in a surprising number of instances (Fig. 2).

While it is known that all of the dye is eliminated through the kidneys within forty-eight hours, the rate of clearance has not been hitherto determined. To this end several patients were examined at frequent intervals for twenty-four hours following oral administration of priodax, and an attempt was made to increase the density of the dye in the renal pelvis and calices by means of restricting fluids to the patient and compression of the lower abdomen for a suitable time before each roentgen exposure. At no time during this study was the dye in the kidney sufficiently increased in density to indicate that there was any significant interval after ingestion when maximum excretion might be expected.

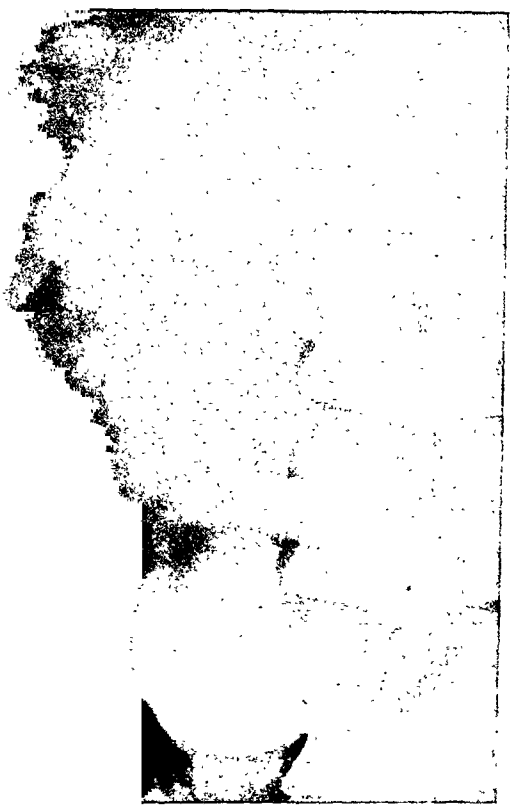


FIG. 1. Cholecystogram after priodax (double dose method) of a patient complaining of indigestion and right upper quadrant pain. Nothing abnormal seen in the gallbladder. Note, however, the faint shadows of the dye in the drainage system of the right kidney. These structures are greatly dilated. A diagnosis of hydronephrosis was made on this evidence and later confirmed by urography.

However, as a result of this experience, it is suggested that two changes be made in the technique commonly employed for cholecystography. Patients should be instructed to refrain from taking any fluids

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Fig. 2. From a roentgenogram made sixteen hours after the oral administration of priodax (double dose method). The dye is seen faintly outlining the normal pelvis and calices of the left kidney.

for ten hours preceding the roentgen examination, and at least one roentgenogram of the upper abdomen should be made on a 14 by 17 inch film with the patient supine and preceded by compression applied to the lower abdomen and pelvis for ten minutes. It is well known that renal disease frequently masquerades behind gastrointestinal symptoms. Indeed, patients have even presented well developed jaundice as the first symptom of an acute right pyonephrosis, and the jaundice has subsided promptly after catheter drainage of the renal pelvis.[3] In many individuals the common bile duct and right renal pelvis are in juxtaposition so that inflammatory disease in one organ produces changes or obstruction in the other. By slight variation in the technique of cholecystography, important information about the kidneys may be gained, and the roentgenologist will be fulfilling his function of obtaining the maximum amount of information concerning the patient from the examination at hand.

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HETEROTOPIC OSSIFICATION IN AN AREA OF METASTASIS FROM RECTAL CARCINOMA

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DEVELOPMENT of new bone in soft tissue neoplasms has been reported infrequently.[1,2,3,4,5] Dukes [6] in 1939 described 4 cases of rectal carcinoma exhibiting this process. Our review of the literature since that time has not uncovered any other instances of heterotopic ossification in non-osseous neoplasms. The case to be reported is unusual in that bone was discovered in an area of regional metastasis from rectal carcinoma.

CASE REPORT

A white male, aged fifty-five, was admitted to the hospital on June 3, 1945, complaining of weight loss and bloody diarrhea of several months' duration. A large, hard, irregular mass was palpable in the rectal ampulla. Physical examination was otherwise negative and routine laboratory work was non-revealing. A one-stage abdominal-perineal resection was performed and aside from some minor postoperative urinary difficulty the patient made an uneventful recovery. No metastases were noted at operation. Microscopically the tumor showed anaplastic epithelial cells forming atypical glands invading deep into the muscle layers. The cells in general had basal nuclei and a moderate amount of cytoplasm. The nuclei varied, some being large, round and vesicular, others being small, deeply staining and oval. Mitoses were frequent. There were areas of necrosis and mucus formation. Infiltration of numerous polymorphonuclear leukocytes and mononuclear cells occurred diffusely.

In February, 1946, the patient complained of pain in the coccygeal region. Roentgenograms at this time revealed only an advanced degree of osteoarthritis of the lower lumbar spine (Fig. 1). The pain became progressively worse and in July, 1946, began radiating down the right thigh and leg. The roentgenogram then showed an irregular moth-eaten appearance of the body of the fourth lumbar vertebra. There was also noted a lobulated shadow of increased density, measuring about 6 by 2 cm., in the right half of the pelvis, adjacent to but not associated with the spine of the ischium (Fig. 2).



FIG. 1. Roentgenogram, February, 1946, showing only osteoarthritis of lumbar spine. No abnormal shadows of increased density.



FIG. 2. Roentgenogram, July, 1946, showing lobulated shadow of increased density in right half of pelvis. Stereoscopically this lies in the region of the spine of the ischium but is not attached.



FIG. 3. Roentgenogram, September, 1946, showing that the radiopaque shadow in right half of pelvis has increased in size. Several small irregular areas of calcification are now present in the left half of the pelvis. The body of the fourth lumbar is increased in density, due to osteoplastic metastases.



FIG. 4. Gross appearance of retroperitoneal bony mass.

Because of the intractable pain, the sacrococcygeal area was explored but no gross carcinoma was found. The coccyx was removed, and on microscopic examination showed areas of necrosis, but no carcinoma. The patient was relieved of his pain and made an uneventful recovery.

A few weeks later the pain in the sacral region recurred and became progressively worse. Numbness developed in the right lower extremity and walking became difficult. In September, roentgen therapy was instituted, but gave no relief. The patient lost weight rapidly and in early October lost voluntary control of urination. Roentgenograms at this time revealed that the lobulated area of increased density had become larger and was more clearly demarcated (Fig. 3). A few small areas of irregular calcification were noted in the left half of the pelvis in the region of the medial border of the acetabulum. The body of the fourth lumbar vertebra showed slight collapse, with increase in density and areas of bone destruction. The body of the third lumbar was similarly involved by the metastatic process, but to a lesser degree. From this time on the patient's condition became rapidly retrogressive and he died on November 11, 1946.

Autopsy Report. Gross examination: The pelvic peritoneum was covered with hard white nodules, ranging from 1 to 3 cm. in diameter. To the left of the bladder was a hard growth that involved the serosal surface of bladder and invaded the prostate. Retroperitoneally a stony-hard, spherical mass (Fig. 4) easily stripped away from the right ischium, immediately above the obturator foramen, leaving an intact periosteal surface. The mass measured 3 by 5 by 6 cm., was white in color, and had a lobulated surface. It was surrounded by a dense connective tissue capsule and when sawed in two presented a white, bony surface, that was divided by several trabeculae.

Metastatic nodules of carcinoma were found on the endocardium of the right auricle, in the liver, lungs, and in the second, third and fourth lumbar vertebrae. Several dozen small faceted stones were present in the gallbladder. The left kidney pelvis contained many soft yellow stones measuring from 0.2 to 0.3 cm. in diameter. Scattered throughout the parenchyma of both kidneys were many soft abscesses measuring from 0.3 to 0.5 cm. in diameter.

Microscopic examination: Sections of the metastatic growths in the liver, lungs, right auricle, prostate and vertebrae showed invading anaplastic epithelial cells, forming atypical glands separated by thin strands of connective tissue. The cells were of columnar type, with small to medium sized nuclei; some of the latter were deeply staining, while others were vesicular. The cytoplasm was abundant and some-

what basophilic. Mitoses occurred in moderate numbers. Large areas of necrosis were present. The growth that invaded the prostate showed areas of mucoid degeneration similar to the original rectal growth.

The retroperitoneal hard mass consisted for the most part of trabeculae of old bone, showing in a few areas small foci of blue granular amorphous material (Fig. 5). Elsewhere there was abundant young connective tissue containing osteoid tissue (Fig. 6). Scattered throughout the mass were atypical glands, some of which formed mucus. There were no leukocytes and few vessels.

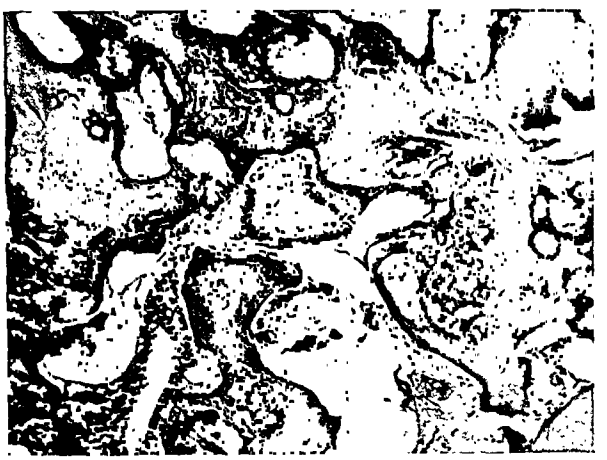


Fig. 5. Decalcified section of mass showing trabeculae of old bone, atypical glands, and mucus.

Section of the kidneys showed bilateral acute pyelonephritis. In none of the organs was there any metastatic calcification.

COMMENT

This case presents an adenocarcinoma of the rectum, which was removed by abdominal-perineal resection. A year after the operation an area of radiopacity was seen in the right pelvis. This opacity had not been present on previous roentgenograms. It progressively enlarged and at autopsy was found to be a spherical, bony mass in the region of the right obturator node. The mass though adjacent to the periosteum of the ischium was not intimately connected with it. It was scooped out with very little effort.

There are two possibilities as to the nature of the bony mass. The first is that there was a pre-existing exostosis to which carcinoma had metastasized. The second possibility is that the carcinoma metastasized to the soft tissue in the region of the obturator node and bone then formed in the metastasis. The latter explanation appears more logical to us. In the former case it would be necessary to postulate that if there were an exostosis, it would have had to separate spontaneously from the ischium, as there was no evidence of any osseous connection between the two. Moreover, one of the earlier roentgenograms would have shown the presence of a bone tumor. It is impossible to rule out the existence of a benign connective tissue tumor, which had been invaded and completely replaced by bone.



Fig. 6. Section of mass showing young connective tissue, osteoid tissue, and atypical glands.

The subject of heterotopic bone formation has been widely studied and a number of theories have been postulated.[3,7] Huggins[8] stimulated much interest in the problem by inducing bone formation in certain connective tissues of dogs and rabbits with transplants of urinary tract epithelium. The explanation of this phenomenon remains incompletely answered, although the theories of Leriche and Policard[7] seem to offer the best explanation as yet presented. They believed that heterotopic bone originates by metaplasia of connective tissue, the two necessary factors being: (1) a young connective tissue medium, and (2) a calcified deposit in the immediate vicinity

of the connective tissue. The calcified deposit, according to them, can be adjacent bone, or necrotic tissue which has become infiltrated with calcium salts.

In our case the metastatic areas contained abundant young connective tissue stroma, and small areas of necrosis and mucoid degeneration. Some of these areas were infiltrated with calcium. The ossified tumor was, moreover, immediately adjacent to (but not directly connected with) the right ischium. Thus, both prerequisites of Leriche and Policard were fulfilled.

The common features noted by Dukes[6] in his 4 cases of ossification in rectal cancer were: (1) long duration of symptoms, indicating slow growth; (2) histopathologic picture of growth of low grade malignancy, with no tendency to spread by veins or lymphatics; (3) presence of necrosis within the tumor. Our case showed necrosis in the tumor, but otherwise differed from the above in that it progressed rather rapidly and metastasized widely.

The problem of the failure of new bone to form more frequently in tumors deserves consideration. Certainly one would think that the coincidental presence of young connective tissue and of a calcium source occurs frequently enough. Two conclusions may be drawn from this, we believe: (1) that other factors besides the two mentioned previously are necessary for bone formation; (2) that small foci of ossification do occur more frequently, but remain undiscovered or at least unreported.

SUMMARY

A case is presented of heterotopic bone formation in an area of regional metastasis from carcinoma of the rectum and the explanation of this phenomenon is suggested.

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IRRADIATION IN CANCER OF THE TONGUE*

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INTRODUCTION

CANCER of the tongue is known to be the commonest malignant lesion of the oral cavity, making up 21 per cent[21] of all oral lesions. Many such growths go unnoticed for months, often being attributed by the patient to gastric upset with accompanying "canker sore." Cancer may start as a small, indurated, painless, nontender ulcer which becomes raised and granular as it increases in size. Pain occurs as a late symptom, a fact which often accounts for the indifference of the patient. The anterior two-thirds of the tongue is the most common site of the disease. With lesions at the base of the tongue, metastatic nodes frequently appear before the patient develops pain, hoarseness, dysphagia or dyspnea.

DIAGNOSIS AND DIFFERENTIATION

Examination of the tongue by visualization and palpation is easy, yet biopsy is the only method of verifying the diagnosis. In appearance, cancer of the tongue may vary from a hard-edged ulcer to a warty growth or indurated plaque. Occasionally no ulcer is visible but marked induration can be palpated.

Complete history and careful examination are important to determine the duration and extent of the carcinoma and the presence or absence of palpable nodes. After confirmation by biopsy, treatment should be instituted immediately for within a matter of days, the rich lymphatic drainage of the tongue[3] may change the character of the case from operable to inoperable with the development of lymph nodes.[24]

White patches on the mucous membrane, or leukoplakia, is a frequent forerunner of malignancy and may appear at any time, often persisting after the primary lesion has healed. It often accompanies luetic glossitis, vitamin deficiencies or it may be the result of irritants such as bad teeth, ill-fitting dentures or excessive smoking.

The percentage of syphilis in cases of cancer of the tongue is high. Levin[1] reported five times greater evidence of syphilis associated with cancer of the tongue than with any other form of cancer. Ackerman and del Regato[1] state that the incidence of syphilis in cancer of the tongue is 20 to 40 per cent, while Sharp and Spickerman[23] found only 13 per cent in their series. It has been suggested that the arsenic used in antisyphilitic treatment may be a predisposing factor in cancer of the tongue. This theory seems practical only when other signs of arsenical poisoning are present, such as skin changes on the hands and feet.

Two lesions are often construed as carcinoma. One is glossitis rhombica mediana which was first described by Borcq and Pautrier in 1914.[25] It is a benign condition with clinical symptoms of indurated, nonulcerated, painless, superficial ovoid or rhomboid mass which is situated just anterior to the apex of the V-shaped circumvallate papillae. The surface is smooth, shiny and red but at times several yellowish tinged papules are present.[15]

The other lesion that is not unlike carcinoma of the tongue is the granular cell myoblastoma. It is a smooth, firm mass covered by the epithelium of the tongue and characteristically the epithelium thins out only over the dome and undergoes changes indistinguishable microscopically from carcinoma.[7] For this reason a deep biopsy must be done for a correct diagnosis. Surgical excision is the treatment but it need not be as radical as for malignancy. These lesions are not affected by irradiation. They are benign in the majority of cases. An exceptional granular cell

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myoblastoma will metastasize and behave like a malignant tumor.

PATHOLOGY

Carcinomas of the anterior two-thirds of the tongue are usually well differentiated squamous cell epitheliomas. They metastasize to the regional lymph nodes and occasionally distant secondary metastases are noted. Lesions arising in areas of leukoplakia are, in many instances, multicentric. However, the degree of malignancy is low with less tendency to involve contiguous tissue and the lymph nodes.

The base of the tongue gives rise to squamous cell carcinoma, lympho-epithelioma and lymphosarcoma. They metastasize to the regional lymph nodes as well as to distant areas.

Previously the figure for distant metastases that could be appreciated clinically was 2 per cent.[22] Sachs[22] reports 9.7 per cent with distant metastases on the basis of autopsy findings and 5.4 per cent on the basis of clinical findings. Lenz and Sproul[12] state that generalized secondary metastases are rare except in the transitional cell carcinomas. This type is now considered squamous cell epithelioma of a lesser degree of differentiation without keratinization.

In the past it was believed that the degree of histological differentiation of the tumor had a marked effect on the end results of treatment. In view of the varied responses, however, it is now felt that this is no longer true.[18] It is our impression that the rare anaplastic lesion of the anterior two-thirds of the tongue is less amenable to surgery or to radium needles and it is best treated by intensive roentgen therapy which includes the lymph bearing areas. In these lesions disease is usually well beyond the limits that can be appreciated clinically.

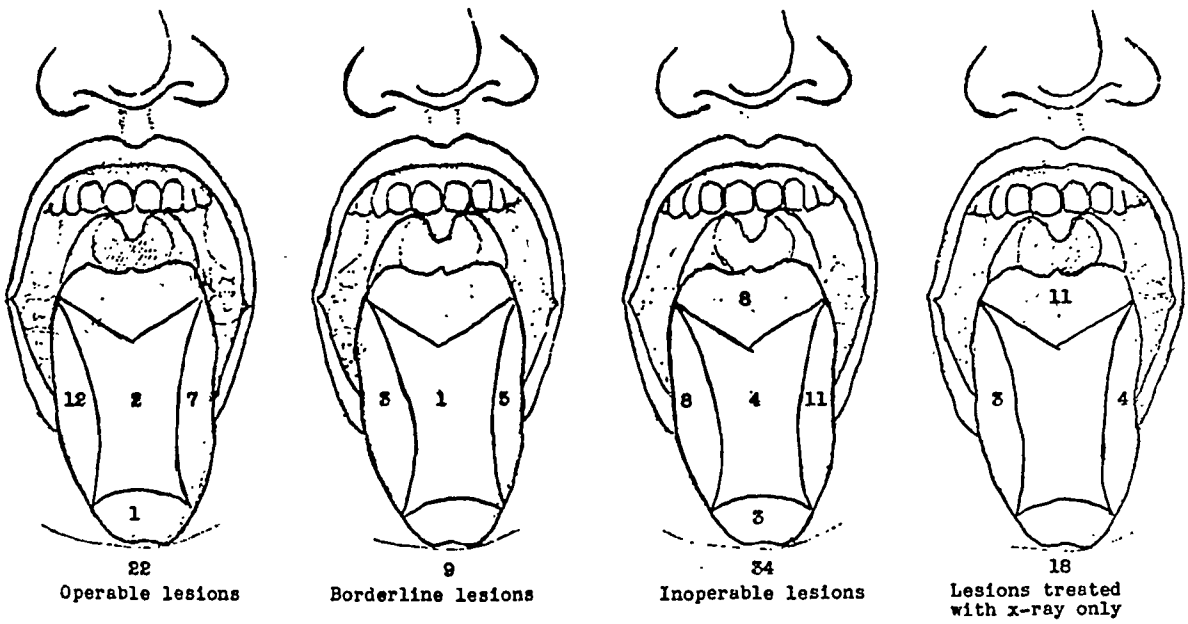


FIG. 1. Location of tongue lesions.

CLASSIFICATION

For the purpose of classifying the sites of the primary lesions, Morrow's[18] suggestion has been used. Of the 167 cases reviewed by him, 56 lesions occurred on the left border of the tongue and 44 on the right border. On the mid-dorsum of the tongue there were 20 lesions while 3 arose on the tip and 42 on the base of the tongue.

The accompanying diagrams (Fig. 1) illustrate the location of the lesions in this study divided as to their operability.

In some clinics, surgery is the treatment of choice for primary lesions of the tongue while in others, irradiation is preferred. In 1940 Martin *et al.*[16] analyzed 556 cases of cancer of the tongue dividing the cases into operable, borderline, and inoperable groups. They favored irradiation at that time and the above terms indicate the classifications which are useful to both methods.

The operable cases had small lesions which might have been excised with a 1.5 cm. margin of normal tissue to insure removal of any extension not grossly evident. There were no palpable nodes, or if nodes were palpable, they were small and unilateral on the same side as the lesion. The general condition of the patients was good, making up the last essential for surgically favorable cases.

The inoperable cases included the advanced or recurrent lesions as well as cases involving the base or posterior one-third of the tongue and those invading the floor of the mouth and anterior fauces. Into this group, too, fell all cases with involved cervical nodes on the side opposite to the lesion, bilateral nodes or inoperable nodes on the same side as the lesion and lastly, all patients with poor general condition. We added to this group all lesions which started on the border of the tongue and extended across the midline.

The borderline cases were those which fell into no definitive group but were usually considered inoperable.

The merits of this classification are that it is applicable to both irradiation and surgery in establishing definite criteria for treatment as well as in simplifying and clarifying analyses.

TREATMENT OF TONGUE LESIONS

Radiation for the treatment of cancer of the tongue is preferred for several reasons, the most important being, from the patient's point of view, that no impairment of speech occurs. From the medical standpoint, the mortality of the technical procedure is almost nil. Finally, although it is difficult to evaluate accurately because of the conflicting reports in the literature, it is generally believed that the five year survival rate is higher.[10,19]

Radium needles interstitially are used in most cases involving the anterior two-thirds of the tongue. Occasionally external roentgen therapy is given first to reduce the infection and possibly the size of the lesion. However, because intensive irradiation devitalizes the tissues, dental extractions after treatment may result in necrosis of the bone. For this reason all carious teeth are removed first. If the dental work is extensive enough to delay treatment, only the teeth on the side of the lesion are extracted and five to ten days following this radium is implanted. If the mouth is clean and edentulous, the course will be smooth. Since the teeth cannot be properly cleaned during the period of irradiation, bacteria lurking at the base of the remaining teeth may give rise to infection. To prevent this eventuality, the patient is started on chemotherapy twenty-four hours before the insertion of radium. By continuing chemotherapy throughout the full treatment time, the discomfort from superimposed infection has been completely eliminated. As with any operative procedure, a good night's rest is insured by adequate sedation. Breakfast is withheld and morphine is given one-half hour before anesthesia which is obtained by a bilateral mandibular block including the lingual nerve.

The radium needles generally used are 3.2 cm. long with an active length of 2 cm., containing 1.98 mg. of radium filtered through 0.5 mm. of platinum. Each end of the needle has an inactive portion of about 0.5 cm. The sharp bevelled point permits easy penetration of tissue. The opposite end has two eyes which are threaded. The eye nearest the shaft contains a fine black silk suture on which a small curved cutting edge needle is threaded. The distal eye has a special serum proof silk sufficiently long to attach to the cheek after the radium has been inserted.

The tongue is gently held by an assistant and extended without the use of clamps or

sutures. The sites of insertion are decided upon before any needles are implanted so that only one puncture is made. In selecting the sites, the distance from the mandible is carefully considered. The needles are placed at least 0.5 cm. from the lateral margin of the tongue to prevent over-irradiation of the bone which might lead to osteomyelitis. The ideal distribution of the needles is obtained when they are placed 1 cm. apart. This prevents necrosis of the tongue and also delivers a more uniform dosage. Each radium needle is sewed to the tongue with one black silk suture which is tied loosely. Moderate edema tightens the tissue around the sutures so that the needles are held firmly without damage to the tongue and only rarely does a needle come out. Radium applied in this way is no more traumatizing than the insertion of radon seeds. The entire procedure including the nerve block requires little more than thirty minutes. A diagram of the tongue with the radium needles in place is shown in Figure 6.

The radium needles remain in place until a calculated dose of 8,000 gamma roentgens or more is given, usually five to seven days, at which time they are removed easily by cutting the silk suture and by applying gentle traction on the radium thread. At the time of removal, bleeding is minimal and can be controlled by gentle pressure.

The accompanying reproduced roentgenogram (Fig. 7) shows the radium needles in place. The one horizontal needle was inserted in the floor of the mouth because the lesion extended almost to the gingival gutter.

During the period of application, the patient is kept comfortable with analgesics. Fluid balance is maintained usually by oral administration but the occasional recalcitrant patient is given intravenous solutions. Most patients can take a semi-solid diet but citrous fruit juices are to be avoided because of discomfort to the patient. Mouth irrigations are given every three hours for comfort and cleanliness but in spite of this measure, the tongue becomes coated, furred and foul. When this complication becomes severe, glycerine applied gently with a soft cotton swab is helpful. There is great individual variation in the amount of local pain present and if severe, it can be controlled by cocaine spray. The patient is hospitalized for the radium application but is not confined to bed.

Since the radiation reaction is not expected for a week or ten days following the treatment, the patient is usually discharged the day following removal of the radium and thereafter is followed in the outpatient. department. The reaction is characterized by a severe glossitis, a painful burning sensation and the formation of a white membrane uniformly covering the irradiated area. Because the inactive portions of the needles are nearest the palate, only a slight reaction develops here. The peak of the reaction is attained about three weeks following treatment and then gradual subsidence takes place. During this time the patient is given sedation either mild or moderately heavy as indicated by the severity of the reaction. By the time the tongue is healed sufficiently to tolerate palpation, the ulcer has disappeared and if the response has been favorable, only a mild induration persists.

Three methods may be used for treating inoperable cancer of the tongue. The lesions located on the anterior two-thirds may have interstitial radium although it is not unusual to substitute roentgen therapy by means of an intraoral cone. If the latter method is chosen, an attempt is made to deliver 5,000 r tumor dose, using a cone 3 cm. or 4 cm. in diameter. Treatment of lesions located at the base of the tongue is usually done by external irradiation with an 8 by 10 cm. field to each side or occasionally a 6 by 8 cm. field to each side and one submental field is used. Two fields are treated daily, giving 100 r to 150 r in air to each field until a tumor dose of 5,000 r to 6,000 r is delivered.

TREATMENT OF NODES

The treatment of the nodes in cancer of the tongue remains a controversial subject

and the procedures used have been varied. A prophylactic neck dissection on the side of the lesion may be done or a complete bilateral neck dissection down to the clavicle. Some clinics treat nodes as they appear by the insertion of radon seeds and others use external irradiation. Still others give preoperative roentgen therapy to the neck while the primary lesion is being treated and follow this with a radical neck dissection. Occasionally in rapidly developing lymphatic involvement where the delay necessary to treat the tongue lesion first may result in the nodes becoming inoperable, a neck dissection is done first.

Morrow[18] reported that of 98 cases, 59 had palpable nodes of which 22, or 38 per cent, showed no metastases. However, of 18 cases without palpable nodes, 7, or 39 per cent, showed metastases. He recommends surgical treatment of the tongue and bilateral neck dissection to the clavicle. In cases where unilateral or bilateral node dissection was followed at a later day by a supraclavicular node dissection, a 50 per cent survival rate was obtained.

The mortality rate for surgery since 1930 has been 16.7 per cent. For all cases without nodes, 32.4 per cent survived five years, and 11.5 per cent of cases with nodes survived five years.[18]

Martin *et al.*[16] recommend that the nodes be handled by irradiation as they appear. They base this opinion on a review of 118 cases without nodes in which only 22 per cent developed metastases later. If radical neck dissection had been done on all the cases, 92 useless operations would have been performed. The operative procedure carries a 10 per cent mortality.

Each node is treated through a small portal receiving 4,000 r to 8,000 r externally and this is followed by 5 to 10 threshold erythema doses with radon seeds. Radon seeds alone are used for isolated, outlying nodes or for small nodes recurring after treatment.[16] External irradiation alone is used for anaplastic and very radiosensitive lesions.

Raven[20] states that metastatic nodes occur in 69 per cent before six months and in 27 per cent before two months. Of the 188 cases without nodes treated by Martin,[16] only 22 per cent developed metastases later. In our group of 22 cases without nodes (operable group), 6 prophylactic neck dissections were done on the side of the lesion. Only one showed microscopic evidence of disease.

In this hospital we usually do a prophylactic neck dissection on the affected side six weeks following the insertion of radium in the tongue if the lesion appears controlled and did not cross the midline. This is done whether or not nodes are palpable. The patient must be in good general condition and, on a statistical basis of age, life expectancy should be five years or more. If the nodes are indefinite in outline or fixed to the underlying structures external irradiation up to 3,500 r to 4,000 r in air is given to one 8 by 10 cm. or 10 by 15 cm. field at the rate of 200 r to 250 r daily. Occasionally additional irradiation—1,000 r to 1,500 r in air—is given through small cones to individual nodes.

Early in this series large radium packs were applied externally to the neck for treatment of nodes. This method was discarded some time ago because external roentgen therapy has proved more effective. Occasionally radium needles or radon seeds have been inserted in metastatic nodes. The fibrosis and scarring produced by interstitial radium needles causes excruciating pain in the neck. We feel now that this is unwarranted and prefer external roentgen treatment. This extensive scarring and fibrosis does not follow interstitial radium in the tongue because of the better blood supply.

Considering Morrow's[18] good results with bilateral neck dissection, this procedure may be done more frequently in the future.

MATERIAL

Eighty-three cases of carcinoma of the tongue admitted to the Radiotherapy Department of the Presbyterian Hospital from December 2, 1929 to February 8, 1946 were reviewed. All were proved by biopsy. They were classified according to

the criteria mentioned above and the tumor dose was calculated for each case. The Paterson and Parker charts were used for the determination of the radium dose and the K. S. Cole graph was used for the roentgen-ray dose. All dosages mentioned refer to actual tumor dose. The roentgen-ray factors were 200 kv., 25 ma., 50 cm. target skin distance, with 1 mm. Cu plus 1.25 mm. Al filter. The average daily dose was 200 r to 250 r in air and the duration of treatment was four to six weeks. The size of the fields varied too widely to be listed here.

Radium dosage in gamma r	Pre-radium dosage in x-ray	Survival period: Under 1 year	1 to 2 years	2 to 3 years	3 to 5 years	5 to 10 years
			Case number			
4400r - 5000r			5			
" " +	3000r					17
5400r - 6600r		4	9			7'*
" "			21*			10"*
" "			22'*			13"°
" "						14"*
" "						18
" " +	5580r		15			
" " +	1400r		16			
7000r - 8500r		8		2°		1'
" "		12'°		6		3'°
9000r - 10,000r				20'		11"
" "						19*

'Cases with unilateral neck dissection. °Died of other causes.
"Cases with bilateral neck dissections. Cases 1, 17, 18 lost to follow-up.
*Patients living and well.

FIG. 2. Operable tongue lesions.

Twenty-two cases were classified as operable. The average duration of symptoms was 9.25 months as compared to seven months quoted by Sachs,[22] Martin *et al.*,[16] and four months by Cade.[4] There were 15 white males, 1 negro male and 6 white females which is a ratio of approximately 1 female to 3 males. The average age was 58.4 years. Serology tests were done on 17 patients. Of these 6 were positive for syphilis.

Nine patients were edentulous, 3 had teeth in fair condition and 10 had poor dental hygiene. Smokers and non-smokers were equally divided. The most common site of the lesions is the lateral border. Leukoplakia was present in 6 of the cases.

The table in Figure 2 shows the tumor dose and survival period of the operable lesions with each case designated by number. Ten of 19 patients survived over five years, giving a survival rate of 52.6 per cent. Three patients were admitted after 1942 and therefore could not be included in this percentage rate. Seven of the surviving 10 cases had neck dissections, 4 of which were bilateral. Of these 4, only 1 (Case 11) had histopathological evidence of disease in the nodes.

Nine cases were classified as borderline. The average duration of symptoms was 7.4 months. There were 7 white males, 1 negro male and 1 negro female. The average age for the group was 65.5 years. Only 6 histories recorded the serology; of these, 3 were positive for syphilis. Five patients had poor teeth, 1 was edentulous and 3 had fair dental hygiene. Three patients were heavy smokers, 3 were moderate smokers and 3 histories gave no reference to smoking. Leukoplakia was present in 3 cases. The site of the lesions with the number of cases for each is shown in Figure 1.

Figure 3 shows the tumor doses and survival period of the 9 borderline cases with each case designated by number. None of the cases are represented in the five to ten year column although Case 8 and Case 9 are too recent to have attained that survival period. Both are living and well. On Case 8 a unilateral neck dissection was done five months after treatment of the

tongue lesion. The nodes were positive for cancer histopathologically.

Case 3 had pulmonary and esophageal metastases and Case 5 had metastasis to the femur.

16 used tobacco. Eleven of 34 patients had leukoplakia. Location of the lesions is shown in Figure 1.

A summary of the tumor dose and survival period for each case in this group is

Radium dosage in gamma r	Pre-radium dosage in x-ray	Survival period: Under 1 year	1 to 2 years	2 to 3 years	3 to 5 years	5 to 10 years
		Case number				
5000r - 6000r +	7600r		3			
" " +	1200r			7		
6000r - 7500r		2	1			
" "		5	6			
" " +	3960r		4			
8810r				9†*		
11000r					8*	

†Case with unilateral neck dissection.
*Patients living and well.

FIG. 3. Borderline tongue lesions.

Radium dosage in gamma r	Pre-radium dosage in x-ray	Survival period: Under 1 year	1 to 2 years	2 to 3 years	3 to 5 years	5 to 10 years
		Case number				
3900r - 4600r			5†			
" " +	6000r	27	8†			
" " +	1500r		16			
4600r - 6000r		9†				
" "		12				
" " +	5000r	11				
" " +	8500r	10				
6000r - 7500r		7	2"		24*	18*†
" "						20*†
" " +	2000r		13†			
" " +	4000r				14	
7500r - 9000r+			1	28*		17†
" "			33*	29*†	25†	
" "				34*		
" " +	5890r		6			
" " +	2500r	23			22°	15°
" " +	1000r					18*
" " +	2000r	21				
" " +	7800r				3"	

†Cases with unilateral neck dissection.
"Cases with bilateral neck dissections.
*Patients living and well.
°Died of other causes.
Cases 4, 26, 30, 31, 32 lost to follow-up.

FIG. 4. Inoperable tongue lesions.

There were 34 inoperable cases in which the average duration of symptoms was 7.5 months, approximately two months lower than for the operable group. Twenty-seven white males, 1 negro male and 6 white females were represented with an average age of 58.4 years. Of 24 histories giving reference to serology, 9 were positive for syphilis. Of 23 dental histories 14 had poor teeth, 2 had fair dental hygiene and 7 were edentulous. Twenty patients were questioned about their smoking habits. Of these

shown in Figure 4. The condition of the nodes was mentioned in 30 histories and of these, 12 patients, or 40 per cent, had palpable nodes on admission. These were thought clinically to be metastatic. Of these 12 patients, only 4 had neck dissections. Two patients (Cases 2 and 3), both of whom had palpable nodes before treatment of the primary lesion, had bilateral neck dissections. The nodes on both sides showed histopathological evidence of carcinoma. Case 2, who had 7,479 gamma roent-

gens to the tongue lesion, died at the end of twenty months of pulmonary metastases. Case 3 was given 7,800 r intraorally plus a tumor dose of 8,900 gamma roentgens to the tongue. Two years later he developed a local recurrence and this was treated with 4,909 gamma roentgens. He died three years and six months after admission with metastases to the eye and with extensive local disease.

Two cases (5 and 8) had unilateral neck dissections before the primary lesion was treated because the tongue lesions could not be diagnosed. In Case 5 the primary lesion was discovered six months after the neck dissection and in Case 8 the tongue lesion was diagnosed two years after the neck dissection. Both lesions were situated at the base of the tongue. Case 5 died of cancer four months after the insertion of radium while Case 8 died two years after radium insertion or four years after the neck dissection.

Five unilateral neck dissections on the affected side were done. Two had palpable nodes on admission. These were positive for cancer histopathologically and both patients died within one year. Of the 3 cases with no palpable nodes, 2 had histopathological evidence of disease in the nodes. Case 19, with histopathological evidence of disease in the nodes, is living and well five years. Case 20 with histopathological evidence of disease in the nodes had had a partial glossectomy one month prior to the radium insertion which was done for the rapid recurrence of the disease. He is living and well six years after radium insertion. The patient with histopathologically negative nodes had involvement of the lip, floor of the mouth and gum. He received 7800 r plus 7,600 gamma roentgens. Four years after admission he had a local recurrence and died of local disease two years after the recurrence.

Four unilateral neck dissections were done on cases admitted within the past three years. Case 25 now has disease in the opposite side of the neck although the lesion did not cross the midline. His neck dissection was delayed until nodes were palpable. Five of 23 patients lived five years or more giving a survival rate of 21.7 per cent. Eleven cases were admitted after 1942 and therefore could not be included in this percentage.

Eighteen patients were treated by roentgen irradiation alone. All were inoperable because of the site of the lesion or extent of the disease except two. Cases 14 and 16 had small lesions but their general condition would not permit the use of interstitial radium. The average duration of symptoms was 5.8 months. There were 13 white males,

X-ray tumor dose	Survival period: Under 1 year	1 to 2 years	2 to 3 years	3 to 5 years	5 to 10 years
	Case number				
3260r - 4500r	1		14*		
" "	8				
4500r - 5000r	5	18		10	
" "	6				
" "	15				
5000r - 6000r	11	2		12	4°
" "		17		13	7
6000r - 7000r		16*	9		
7000r - 8000r	3				

*Patients living and well.
°Died of other causes.

Fig. 5. Tongue lesions treated with roentgen irradiation only.

2 negro males, 1 Chinese male and 2 white females. The average age was 62.7 years. Twelve histories recorded the serology of which 4 were positive for syphilis. Sixteen histories recorded the condition of the teeth. Of these, 9 had poor teeth, 2 had fair dental hygiene and 5 were edentulous. Tobacco history of 13 patients showed 4 heavy smokers, 6 moderate smokers and 3 non-smokers. One had leukoplakia. The site of the lesions with the number of cases for each is shown in Figure 1.

The table in Figure 5 shows the tumor dose and survival period with each case designated by number. Eight cases, or

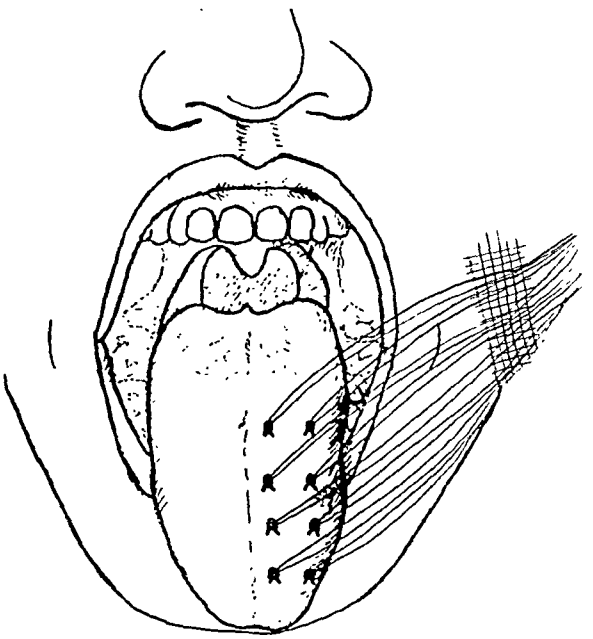


Fig. 6. Diagram of the tongue with radium needles in place.

44.5 per cent, had palpable nodes on admission; 6 had no palpable nodes and in 4 the nodes were not mentioned. No neck dissections were done.

Two of 13 patients, or 16.9 per cent, lived over five years. Six patients were admitted too recently to be included in this percentage group. Case 4 with a lesion at the base of the tongue received a tumor dose of 5,250 r. He died of pneumonia eleven years after treatment with no evidence of disease in the tongue. Case 7 also had a lesion at the base of the tongue which received a tumor dose of 5,400 r. He died of



Fig. 7. Roentgenogram showing radium needles in place.

coronary thrombosis eight years after treatment. The autopsy showed a superficial recurrence in the tongue.

The 2 cases with small lesions on the lateral margin of the tongue, who were poor risks for radium insertion, are living and well two and a half and one and a half years without evidence of disease in the tongue or neck. Case 14, living two and a half years, received 4,400 r tumor dose with an intraoral cone. Case 16, living one and a half years, received 6,600 r.

Two of the 18 cases had pulmonary metastases.

Martin[16] reported a five year survival rate of 57 per cent for the operable group treated by irradiation, surgery, or a combination of both. The inoperable group showed 7 per cent five year survival rate while borderline cases showed 36 per cent. The survival rate for the entire group was 25 per cent but 45 per cent for those who had no metastases at any time.

According to Greenwood, quoted by

Lane-Claypon,[11] 16.4 months is the average natural duration of life without treatment.

CONCLUSION

Eighty-three cases of carcinoma of the tongue were treated from December 2, 1929 to February 8, 1946. Radium needles interstitially in the tongue, interstitial radium needles in the tongue plus roentgen irradiation, and roentgen irradiation alone were the methods of treatment used. Patients treated after 1942 could not be used in estimating the over-all five year survival rate. Therefore, only the patients treated up to 1942 were included. There were 55 patients, 17 of whom survived five years or more, giving an over-all five year survival rate of 30.9 per cent. This compares favorably with the results of other clinics. All but a few received an adequate tumor dose. An attempt is made to give 8,000 gamma roentgens or more to the tongue when interstitial radium needles are used. If the radium dosage is less, supplementary roentgen therapy is given. Lesions that persist after the usual radium dose is given, receive roentgen therapy. When roentgen therapy alone is used, the aim is to give a tumor dose of 5,000 r to 6,000 r.

The longest duration of symptoms was in the operable group. This is ambiguous for one would expect to find longer duration of symptoms in the more advanced cases. There seems to be no explanation for this.

It is apparent that the size and extent of the lesion as well as the location are the most important factors in determining the prognosis regardless of the tumor dose given. However, until more is known about the biological behavior of cancer and the host's susceptibility and immunity, the accepted tumor doses must be given. Patients are given the full course of irradiation initially.

We favor neck dissection because we know that frequently much normal tissue is damaged by external irradiation without eradicating metastatic disease. No convincing argument can be made for neck dissection because of the small number of cases. Neck dissection does salvage the group of patients with histopathological evidence of disease in the nodes without clinical evidence of metastases. Whether the cases salvaged in this way are greater than the operative mortality cannot be stated from these cases. One patient died as a result of postoperative complications, but again the group is too small for any definite statement.

SUMMARY

1. Eighty-three unselected, consecutive patients with cancer of the tongue are reviewed. Fifty cases were admitted up to 1942. The group had an over-all five year survival rate of 30.9 per cent.

2. The type of irradiation used in treating the primary lesion is given in detail and the management of metastases is discussed.

3. The tumor dose to the tongue is given for each patient and tabulated for easy reference.

4. A classification for the grouping of cases is described.

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PRECISION DOSAGE IN INTERSTITIAL IRRADIATION OF CANCER OF THE CERVIX UTERI*

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CONSTANT efforts to improve irradiation technique are required by the fact that in the treatment of cancer of the cervix uteri, in some 85 per cent of the cases, irradiation is the only method available since, according to those who perform hysterectomy by choice, only 10 to 15 per cent of the cases are proper subjects for this operation. Despite the fairly satisfactory results following the various irradiation techniques, there is dissatisfaction with the amount of radiation reaching the parametrium by any procedure. Of the various techniques being tried in attempts to bring the tumor dose nearer to the ideal, we chose for study the interstitial method as one which had given superior clinical results and was worthy of an attempt at improvement. Employing the precision stereoscope to check the positions of the needles and to measure the distances between the various units, we have been able to calculate the number of gamma roentgens reaching any part of the pelvic cavity and to devise a pattern which apparently brings adequate gamma roentgen dosage to the uterus and all parts of the parametrium.

The present status of the therapy of cancer of the cervix is the outgrowth of various phases of activity in the past. Following Freund's devising of an operation for removal of the uterus in 1878, it became apparent that while a satisfactory number of patients suffering from cancer of the corpus were cured, practically none with cancer of the cervix survived very long. Vaginal hysterectomy had a much lower operative mortality but the cancer mortality was the same. The radical operation devised in 1894 by Ries,[11] Clarke,[3] Werder,[15] and Wertheim[16] was followed by a considerable number of cures. Some definite principles of radium therapy were established by Bailey[2] in 1915 and others. In roentgen therapy the development of the Coolidge tube permitted the accurate application of large doses of roentgen rays. With these techniques fairly well established, for several years there was a virtual competition between the operative and radiation treatment of cancer of the cervix ending in the abandonment of the operation by nearly all in favor of radiation therapy. This was well expressed by Shaw[12] in 1937: "After careful observation of these cases over seven years, Professor Dougal and I have come to the definite conclusion that radium offers the best chance of cure as well as being the more humane method of treatment. Therefore, strong advocates though we were of the operation, we have now abandoned it." Very shortly, however, it became apparent that some cancers of the cervix were definitely resistant to irradiation and that even in some 21 per cent of the earliest cases there was involvement of the pelvic lymph nodes. This, together with the improvement in surgical management which has reduced the operative mortality so strikingly, has stimulated some[5] to revive the operation with the hope that its permanent results will be better than those obtained by the old masters. Since, however, such a small proportion of the cases are proper subjects for the operation, even if found to be superior in such cases, irradiation remains the only treatment available to the majority of the cases.

The intracavity method of applying radium combined with external roentgen irradiation has become the more or less standard procedure but unfortunately de-

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livers an inadequate tumor dose to the lateral parametrium. While there is some evidence that the quality of the rays may have a bearing on the effectiveness of irradiation, it is much more apparent that the quantity of radiation is what really determines the result. Expressed in terms of gamma roentgens, it is commonly accepted that 7,000 gamma roentgens or more applied to a cancer cell will destroy it without severely injuring the normal tissues. At 15,000 gamma roentgens all tissues are destroyed and a slough created. The problem is to apply an effective dose to all regions in which the cancer is observed or suspected. Although 15,000 gamma roentgens is easily applied to the center of the uterus, the dose reaching the lateral wall of the pelvis is below the minimum tumor dose in nearly all of the techniques employed, whether intracavity radium plus external roentgen irradiation, vaginal cones or the use of interstitial radium needles.[6]

Efforts to overcome this deficiency have been made by increasing the voltage and more accurate beaming of external roentgen rays, by more precise application of the vaginal cones,[4,13] and by the use of radon seeds introduced into the parametrium, controlled by roentgenograms which reveal the scantily supplied areas into which supplementary seeds are then introduced.[1]

We were attracted to the interstitial technique by the superior clinical results obtained by Pitts and Waterman[9,14] and by the reasonableness of the idea that by direct implantation within the area in which radiation was desired, any amount of radiation could be obtained. Our plan of procedure was to determine accurately, by the precision stereoscope devised for pelvimetry, the location of the various radium units placed in the uterus and parametrium, to measure the distance between them and from these measurements calculate the dose which had been delivered to any point in the pelvis.

The capsules and needles were introduced with certain precautions which will be mentioned later. On the day following operation, a precision stereoroentgenogram was made. The distances between the centers of the various radium elements were measured and a tracing of one of the films made on paper on which the measurements just mentioned were recorded (Fig. 4). The cervical mass was drawn to scale and the volume calculated to include 0.5 cm. of tissue beyond the circle of needles. The Paterson and Parker tables[7,8] are used to estimate the gamma roentgens delivered to the volume of tissue. Corrections are made for the 1 mm. platinum filter in the capsules. The radiation from the parametrial needles are determined on the dosage tables for linear radium sources according to Quimby.[10]

Figure 1 is an example of our initial efforts. The intrauterine tandem contained two 10 milligram tubes, 2.3 cm. long, active length 1.25 cm., 1 mm. platinum filter. In the cervical mass were inserted a stockade of eight needles parallel to the cervical canal, with a radius of 1.5 cm. from the cervical canal, 1 cm. apart, length 3.2 cm., active length 2 cm., containing 1.98 mg. radium, 0.5 mm. platinum filter. One centimeter lateral to this circle of needles and, at their point of entrance separated by a distance of 1 cm., were inserted two needles each 6 cm. long, active length 5 cm., containing 4.8 mg. radium, filter 0.5 mm. platinum. Those were directed in a lateral and upward direction and diverged from each other in the coronal plane. The duration of treatment was 120 hours.

Figure 2 is a diagram made from a tracing of one of the films to indicate the positions of the centers of the parametrial needles. The stockade of needles in the uterus and the intrauterine tandem are not represented in detail. In this pattern the irregular order of arrangement is obvious, and is due to the lack of familiarity with this method and a lack of visualization of the position and axis of the uterus and the shape of the parametrium.

The dose is adequate in the cervical mass which received 10,000 gamma roentgens.

The dose in the paracervical tissues was,

on inspection, so obviously deficient that it was not calculated.

The dose in the parametrium at "W" near the lateral pelvic wall was on the right side 2,140 gamma roentgens and on the left 1,315 gamma roentgens. Between the parametrial needles on the right side there was

parallel to the uterus. Then a new principle was introduced. Two 6 cm. needles 1 cm. apart were inserted as close to the lateral pelvic wall as possible, entering the vaginal wall at the junction of the middle and upper thirds and lying in a position parallel to the pelvic wall. It was this procedure which

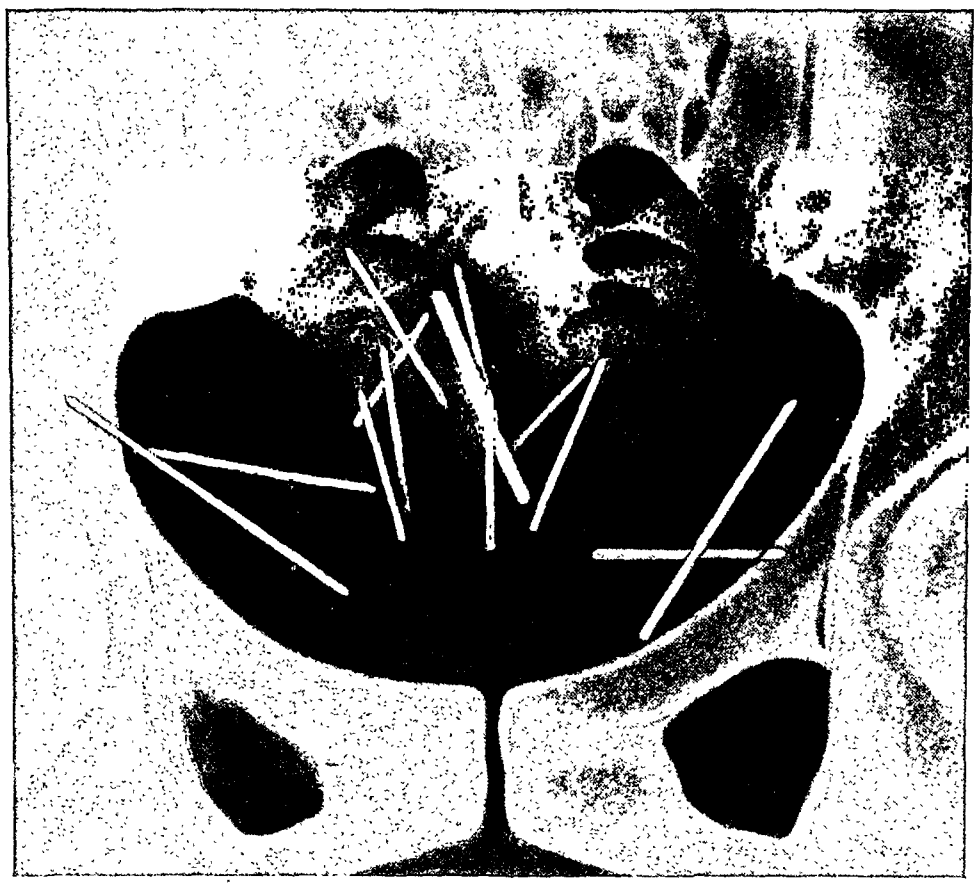


Fig. 1. Case 1. Drawing from roentgenogram showing distribution of radium.

delivered 9,600 gamma roentgens and on the left 6,600 gamma roentgens. The paucity of radiation in the space between needles set wide apart and the sufficiency of the dose between closely placed needles is apparent.

The second case (Fig. 3) illustrates the next step. Three 10 mg. tubes were in the intrauterine tandem. The stockade of eight 3.2 cm. needles with a radius of 1.5 cm. were inserted as in the first case. Then on either side of this stockade, 2.5 cm. distant, was inserted a 6 cm. needle in a direction

led to the devising of a pattern in which all of the needles lay approximately in the sagittal plane. By having the needles more or less parallel, it was possible to add or subtract a unit in order to modify with some accuracy the distribution of radiation.

With the pattern (Fig. 4 and 5) in this second case there was delivered to the cervical mass 14,800 gamma roentgens.

Again the dose in the region lateral to the uterus was deficient, i.e., 1,902 gamma roentgens.

In the lateral parametrium there was de-

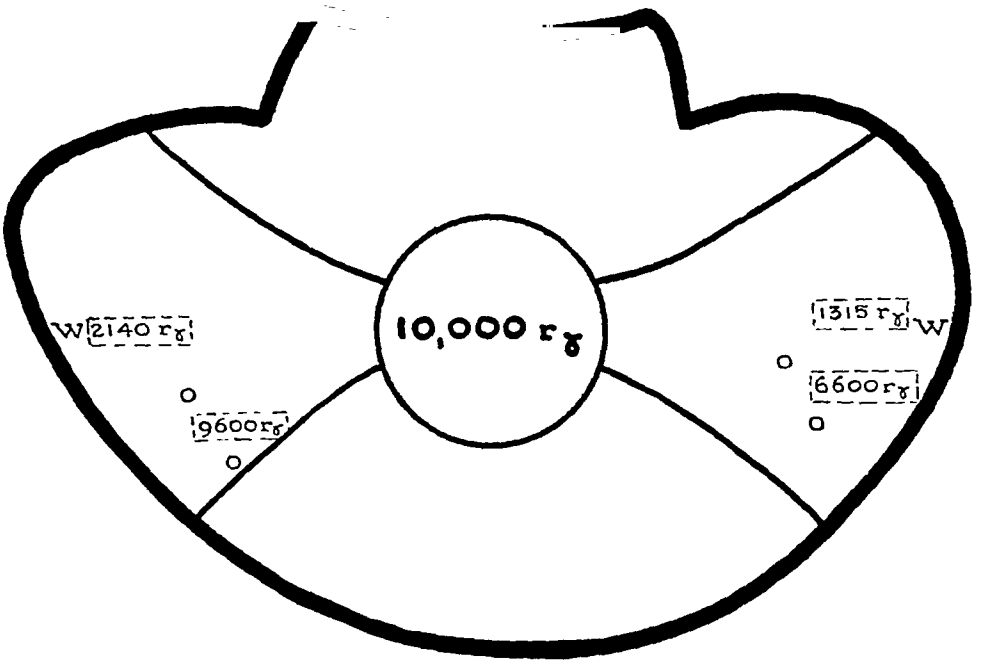


FIG. 2. Case I. Tracing of roentgenogram to show the position of the centers of the parametrial needles and dose in gamma roentgens in the parametrium. The details of the needles in the cervical mass are not shown.



FIG. 3. Case II. Drawing of roentgenogram of pelvis to show distribution of the radium.

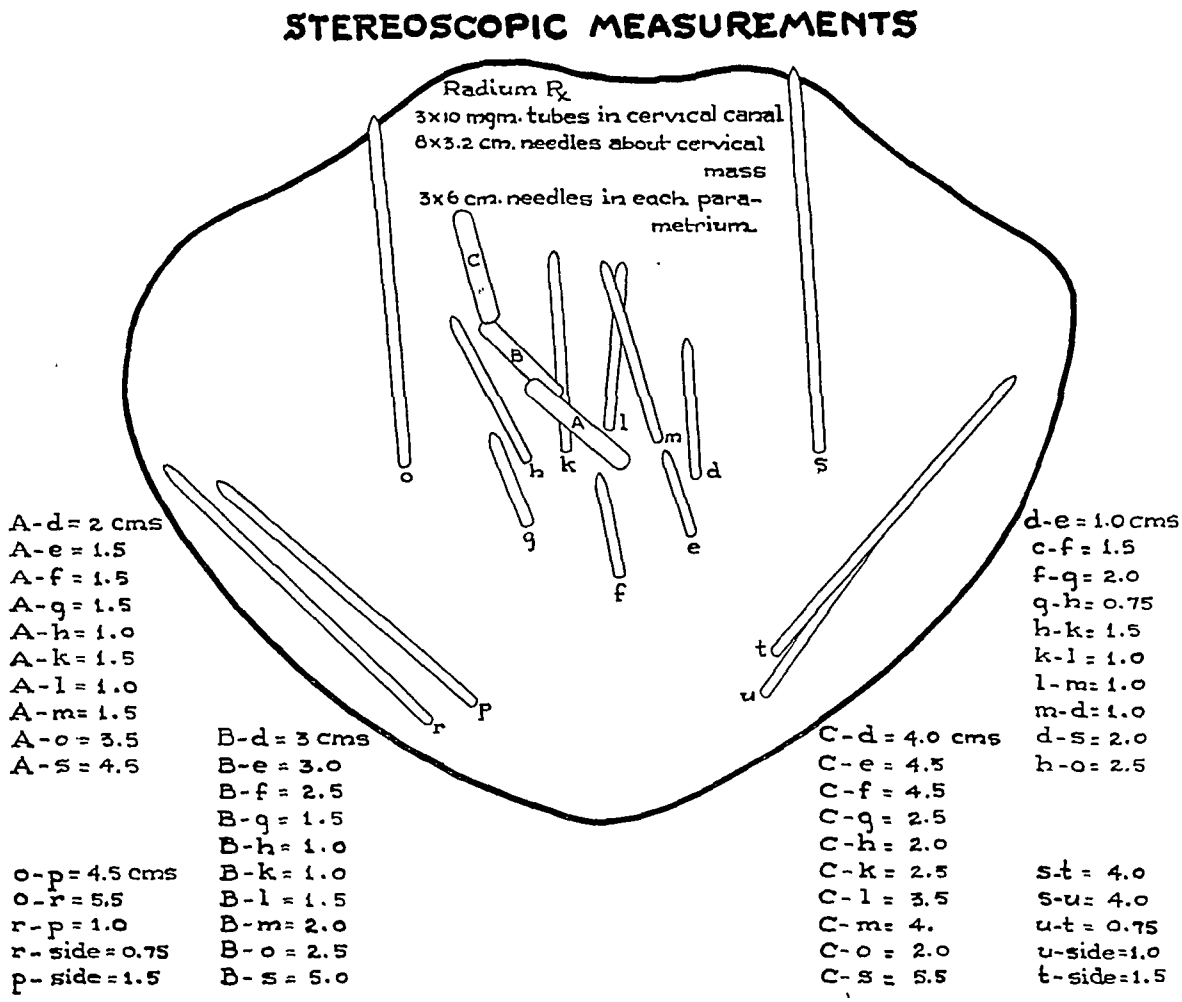


Fig. 4. Case II. Tracing from roentgenogram to show the distances between the centers of the various elements as measured by means of the precision stereoscope.

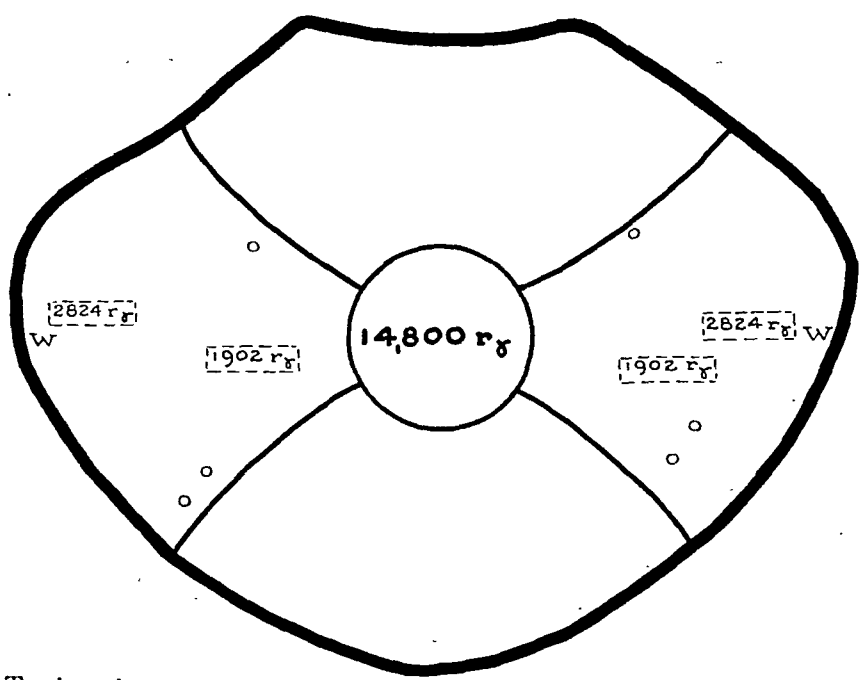


Fig. 5. Case II. Tracing of roentgenogram to show centers of needles and doses in gamma roentgens in different parts of the parametrium. The details of the needles in the cervical mass are not shown.

livered on the right side only 2,824 gamma roentgens and on the left 2,824 gamma roentgens.

Case III (Fig. 6) illustrates the next step. Two 10 mg. tubes were in the intrauterine tandem. The stockade of 3.2 cm. needles had a radius of 2 cm. and were 1.5 cm. to 2.5 cm. apart. This widespread distribution was made because of the enormous volume of the carcinomatous tissue in this particular case. Lateral to this at a distance of 1 cm. and in a direction parallel to the uterine canal, one 3.2 cm. needle was inserted. Lateral to this and parallel to the pelvic wall were inserted three 6 cm. needles 1 cm. apart. On the right side they all lay in a plane parallel to the pelvic wall. On the left side the middle needle lay in a plane about 1 cm. medial to the plane of the other two needles. In this pattern (Fig. 7) the cervical mass received only 9,557 gamma roentgens because of the wide diameter and spacing of the stockade of needles in the cervix.

The parametrial tissues received 5,663.1 gamma roentgens on the right and 5,924 gamma roentgens on the left.

The lateral parametrial tissue at "W" received on the right side 7,000 and on the left 3,009 gamma roentgens. The difference



Fig. 6. Case III. Roentgenogram of pelvis to show distribution of the radium.

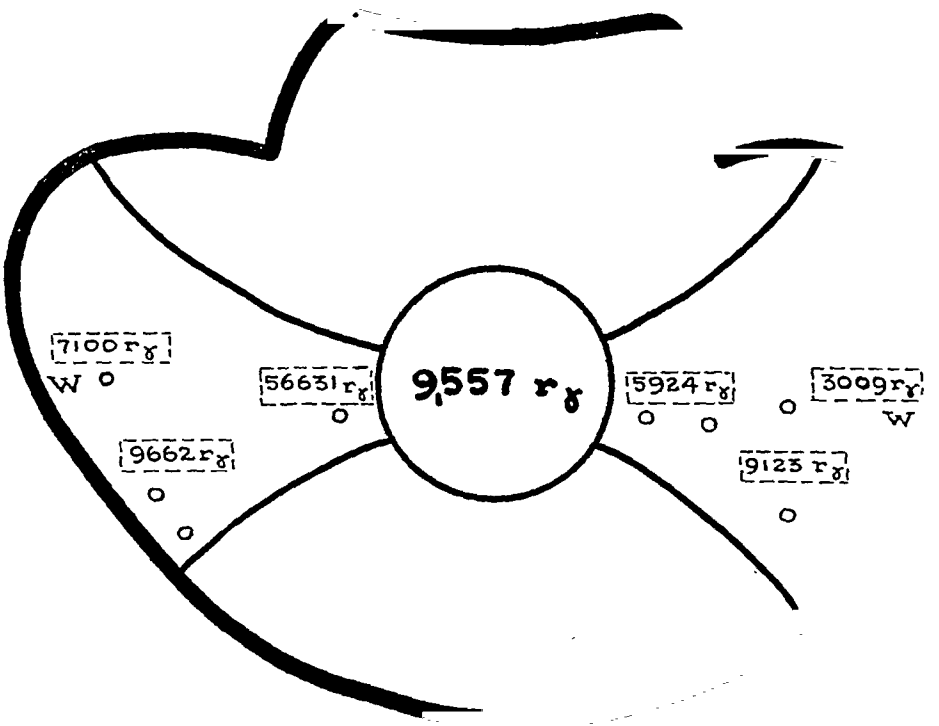


Fig. 7. Case III. Tracing of roentgenogram to show positions of centers of needles and doses in gamma roentgens in various parts of the parametrium. The details of the needles in the cervical mass are not shown.

is due to the fact that on the right side the needles lay in a plane parallel to the pelvic wall whereas on the left side they were placed in a triangular fashion.

In this pattern the dose is beginning to be adequate but the distribution of radiation is still "spotty," being completely adequate where the needles were close together but deficient in other areas.

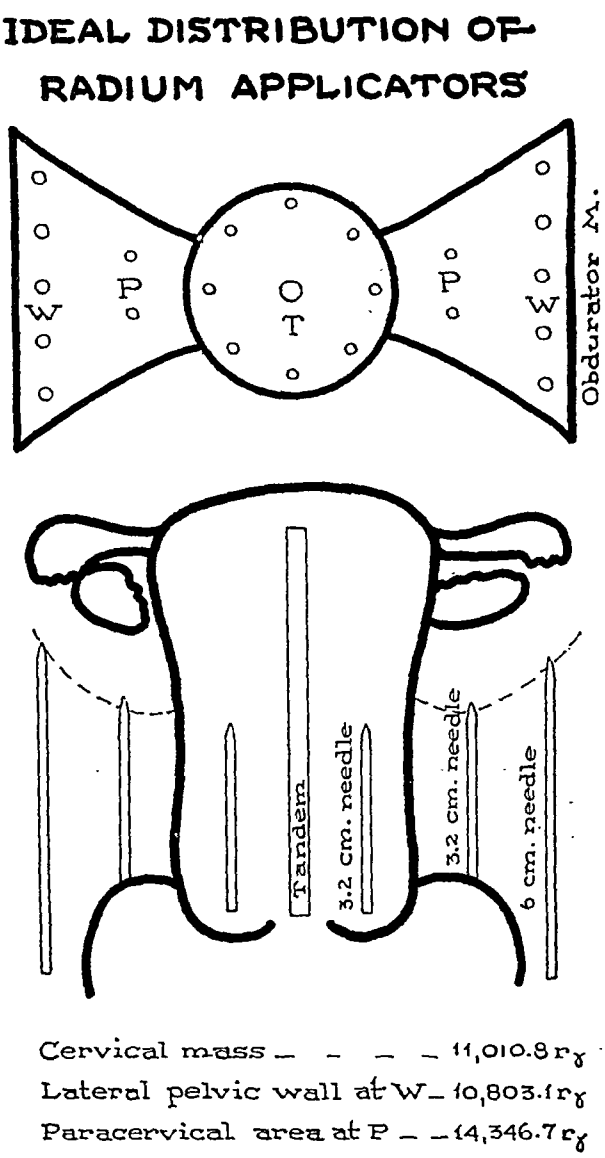


Fig. 8. Diagram to show arrangements of needles to deliver apparently adequate radiation to cervix, paracervical region and lateral parametrium.

We had learned, however, that we could introduce the needles with a considerable degree of accuracy into the positions previously planned. Therefore an arbitrary pattern was devised which delivers apparently adequate radiation to all points in the uterus and parametrium. In this pattern (Fig. 8) there are placed in the intrauterine tandem end to end three 10 mg. tubes. In the previous cases some overlapping of the tubes was necessary in order to get them into the available fountain pen reservoirs made of rubber. With the plastic tubes made to fit these capsules, such overlapping is unnecessary. About this tandem with a radius of 1.5 cm. were placed in stockade fashion eight 3.2 cm. needles.

One and a half centimeters lateral to this and 1 cm. apart in a sagittal plane were placed two 3.2 cm. needles parallel to the axis of the uterus.

One and a half centimeters lateral to these, or 4.5 cm. from the cervical canal were placed five 6 cm. needles parallel to the pelvic wall one centimeter apart.

With this pattern there will be delivered to the cervical mass 11,010.8 gamma roentgens.

To the paracervical region at "P" was delivered 14,346.7 gamma roentgens.

To the lateral parametrium near the pelvic wall at "W" was delivered 10,803.1 gamma roentgens.

Figures 9 and 10 are roentgenograms of a case in which this pattern was employed.

It is assumed that the needles can be inserted as indicated. It will be seen that the dose in the paracervical region is high. If two needles are inserted here, they must be at least 1 cm. apart. In most cases this is made possible by the increase in the anteroposterior dimension of this part of the parametrium by carcinomatous infiltration. In the lateral pelvic region three long needles can be inserted with ease. The anterior and posterior needles can be inserted in a normally distensible vagina.

In one of the preliminary plans a pair of paracervical needles were placed 1 cm. lateral to the stockade of needles in the cervical mass and another pair 1 cm. lateral to this. The radiation from this pattern was to our surprise excessive, giving in the paracervical region a dose of 16,679.4 and

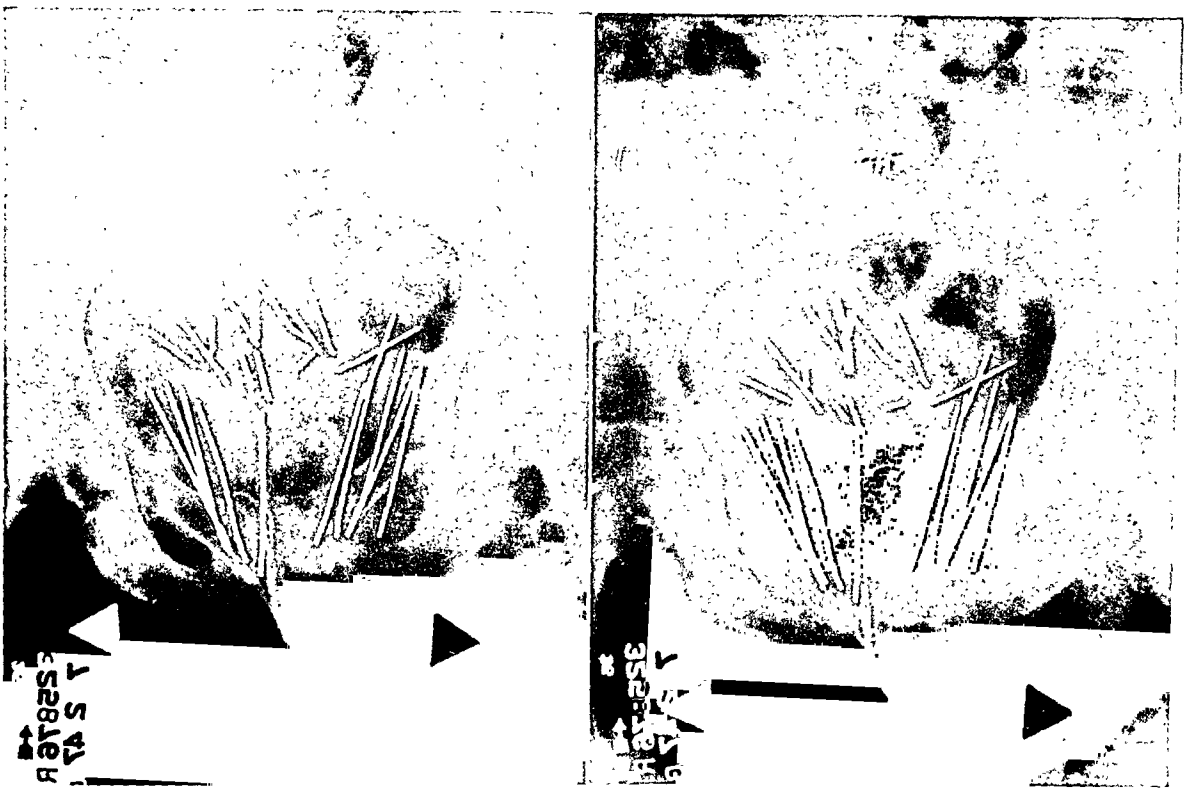


Fig. 9. Stereoscopic roentgenograms of needles inserted according to the plan in Figure 8.

in the lateral parametrium 11,022.7 gamma roentgens.

SUMMARY

These cases and a diagram are presented to show steps in the development of a pattern of distribution of radium units which will provide an adequate "tumor dose" of radiation to the cervical mass, the paracervical tissues and the parametrium out to its lateral limits. It was found that through a vagina which was not greatly deformed, the needles could be placed with considerable accuracy in the positions planned. At first by trial and error and later by calculation a pattern was devised (Fig. 8) which seems to supply adequate tumor doses to the desired places, i.e.,



Fig. 10. Lateral view of pelvis to show direction of uterine and parametrial needles inserted according to the plan in Figure 8.

To the cervical mass, 11,010.8 gamma roentgens.

To the paracervical tissues, 14,346.7 gamma roentgens.

To the extreme lateral parametrium, 10,803.1 gamma roentgens.

In the development of this plan it became apparent that needles, to be effective, must lie 1.0 to 1.5 cm. apart in the mass to be irradiated. Where, in the earlier cases the needles were farther apart than this, the areas between them received insufficient radium. These patterns are devised to fit the needles which are available to us. By employing weaker units set closer together, a still more homogeneous irradiation could be achieved.

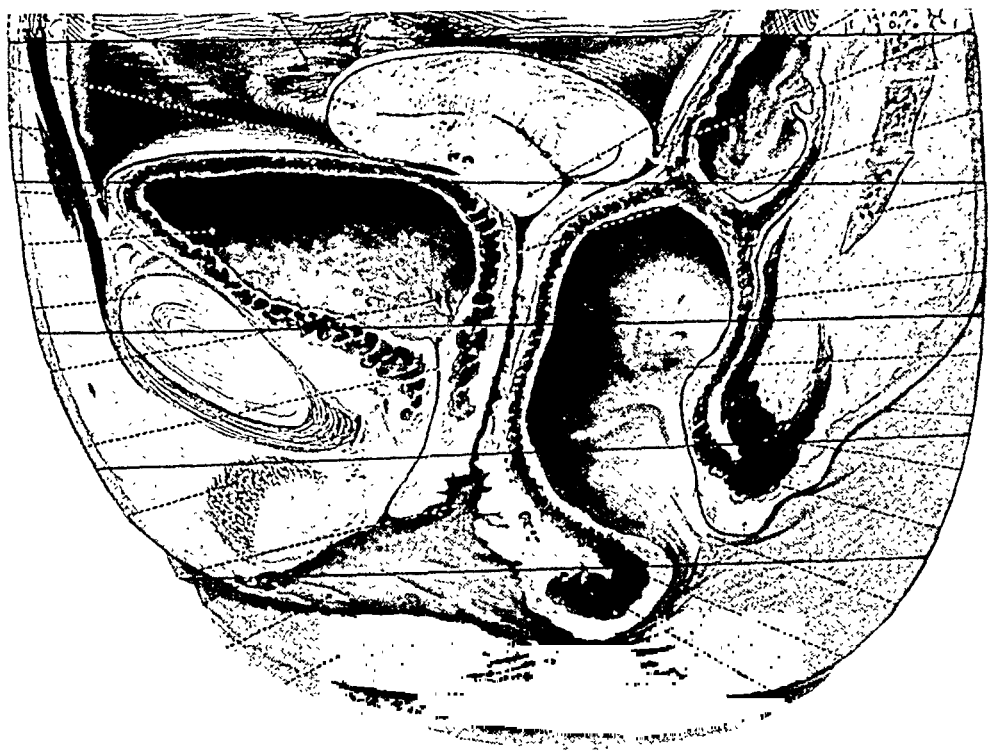


Fig. 11. Sagittal section of female pelvis. (Reproduced by permission from "A Cross-Section Anatomy" by Eycleshymer and Schoemaker. D. Appleton-Century Co., New York, 1911.)

DETAILS OF TECHNIQUE

Anatomy. The axis of the uterus (Fig. 11) is nearly perpendicular to that of the body and in its normal position about 60 degrees to the axis of the vagina. This axis can be changed considerably by traction on the cervix unless there is fixation from carcinomatous infiltration or inflammation. Lack of care in ascertaining this axis accounts for the fact that occasionally needles in the posterior lip of the cervix perforate the posterior uterine wall and enter the peritoneal cavity.

The dimensions of the uterus are important because intrauterine tandems must reach the top of the cavity to destroy endometrium and prevent pyometra. The thickness of the cervical and uterine wall determines the amount of intrauterine radium, the number of needles in the uterus and their distance from the cervical canal. Thin walls, by the law of inverse squares, increase the liability of injury to bladder and rectum.

The paracervical (Fig. 12 and 13) and parametrial tissues occupy an area roughly shaped like a truncated pyramid whose apex lies against the uterus and whose base is on the obdurator fascia. The anterior limits are determined by the bladder and the posterior boundary by the posterior layer of the broad ligament. Inferiorly the

space merges with the paravaginal tissues. Superiorly the space thins out into the true broad ligament near the uterus and laterally is covered by the fascia over the round

base is about 6 cm. vertically and 6 cm. horizontally. The distance from the cervical canal to the obdurator fascia is about 5 cm. The sweep of the pelvis increases this

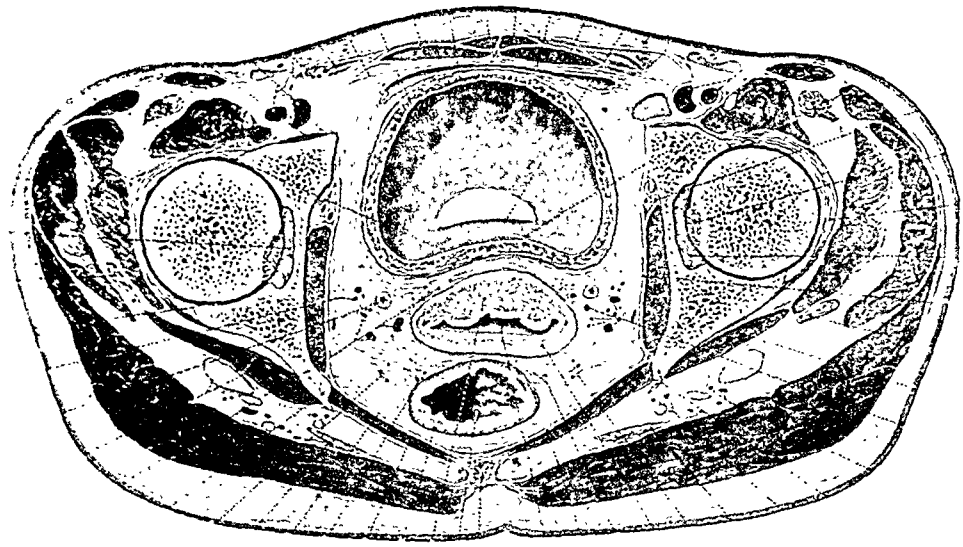


Fig. 12. Coronal section through female pelvis at the level of the tip of the cervix. (Reproduced by permission from "A Cross-Section Anatomy" by Eycleshymer and Schoemaker. D. Appleton-Century Co., New York, 1911.)

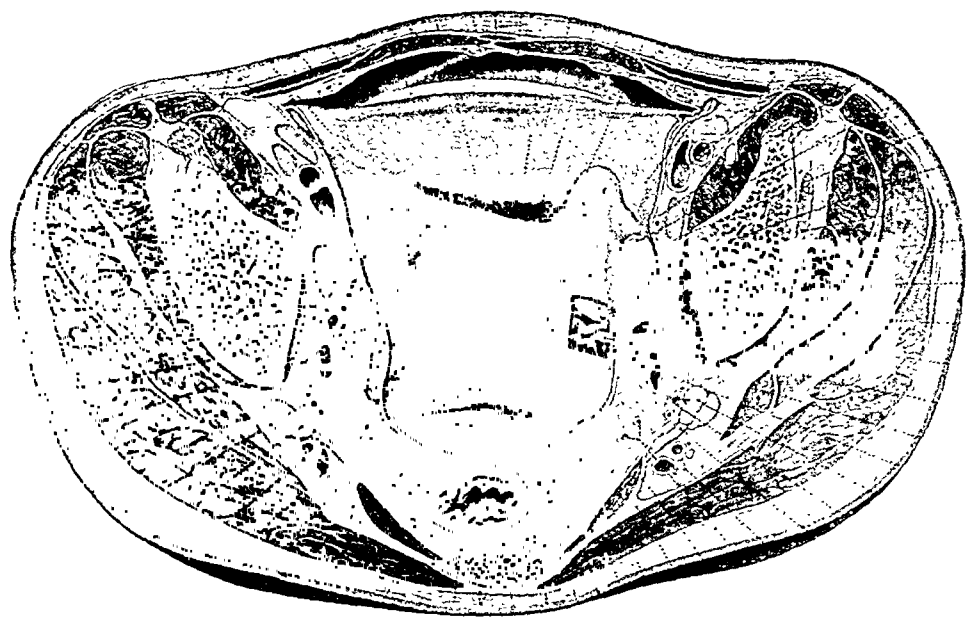


Fig. 13. Coronal section of female pelvis at the level of the fundus of the uterus. (Reproduced by permission from "A Cross-Section Anatomy" by Eycleshymer and Schoemaker. D. Appleton-Century Co., New York, 1911.)

ligament anteriorly and the infundibulopelvic ligament posteriorly. The dimensions of the truncated apex are about 2 cm. anteroposteriorly and 4 cm. vertically. The

diameter posteriorly to about 6 cm. and narrows it anteriorly to about 4 cm.

The normal vagina is urn-shaped with considerable distensibility of the fornices

but in older persons and with carcinomatous involvement, may become a narrow elongated cone and may be distorted or held rigid by carcinomatous infiltration.

Radium Technique. The intrauterine tandem as in any intrauterine radium applicator should cover the full length of the cervical canal, the amount of radium being determined by the thickness of the uterine wall.

The needles introduced into the cervix are 3.2 cm. long and laid carefully parallel to the uterine axis. Those in the paracervical region lateral to the cervical stockade are likewise 3.2 cm. long and laid in the same axis. The needles in the extreme lateral position are laid parallel to the pelvic wall. This is accomplished by retracting the vaginal wall as far as possible laterally with a long narrow retractor. If there is no interference by carcinomatous infiltration, the tissues can be flattened against the lateral pelvic wall so that the needles at their point of entrance are almost against the obdurator muscle and can be inserted in a direction parallel to it. The point of entrance is at the junction of the middle and upper thirds of the vagina.

The pattern of distribution of the needles may be of two kinds, one in which the radiation units are distributed in the clinically apparent carcinomatous tissue and the other in which the units are placed so as to cover all the spots into which cancer of the cervix might spread, irrespective of the palpable mass. This is the pattern which we have employed—inserting the needles according to anatomical landmarks and inserting more needles only when the volume of carcinomatous tissue was so great as to permit the addition of extra needles without danger to the intestine or bladder and in such a manner that they will lie at least 1 cm. distant from any other needle. Other details such as the use of steel wires to control the needles, the preoperative preparation of the patient, preliminary external irradiation, packing of the vagina, the use of a self-retaining catheter, postoperative administration of sulfa drugs, and so forth, are conventional.

DISCUSSION

This is an effort to deliver to all accessible regions a dose adequate to destroy cancer without causing excessive injury to the normal tissue. It is assumed that irradiation has been selected as the best method for the particular case. With this decision made, it becomes academic whether the cancer is or is not sensitive to radiation either in the primary focus or in metastases in lymph nodes. Secondly, we predicate that the rays must be distributed not only to those areas in which the cancer is obvious but also to those in which it may exist in microscopic form.

The implanting of sources of radiation within the cancerous tissues in principle furnishes an ideal method for homogeneous irradiation. If the units are of small strength, they can be placed so as to furnish radiation, obviously greater immediately about the needles, but adequate in the spaces between. This is a simple matter of applying the principles elucidated by Paterson and Quimby. By introducing the sources of radiation directly into the cancer-bearing area, the dose will be maximum in the tumor and diminish rapidly as one goes centrifugally toward the hollow viscera.

The reliability of the measurements made with the precision stereoscope is high. In a test made by interns after six months' obstetrical training with a bony pelvis, the error between the measurements made with the stereoscope and those taken directly from the specimen was less than 2 mm.

While it is our purpose to present only a study of radium dosage to be obtained by interstitial irradiation, we cannot avoid some discussion of the practical problem involved. The principal objection to the method is that it is blind and that the radium needles are likely to injure intestines, bladder and ureter. It requires a pre-

cise knowledge of the anatomy of the pelvis, some degree of surgical dexterity and a knowledge of the principles of irradiation technique. It will hardly be popular with surgeons who do not care to study the principles and details of radium technique nor with radiologists who do not practice surgery.

The mechanical difficulties of inserting the needles in certain cases may be considerable. With the narrow conical vagina without fornices or one whose walls are held rigid or are distorted by carcinomatous infiltration, the manner of introducing the needles and their pattern may have to be altered, but except when the whole vagina is involved in a carcinomatous mass, these difficulties can be overcome, certainly much more easily than is the case with the intracavity method or with the vaginal cone.

Much has been made of the greater likelihood of injury to intestine, bladder and ureter through the use of this method. Mechanically the bladder is rarely injured because of the fact that needles, improperly placed, almost always point posteriorly and not toward the bladder. The ureter will not be injured because of the bluntness of the needles. The rectum or bowel might be injured by needles introduced into the posterior lip of the cervix. Improperly aimed, they perforate the posterior wall of the uterus and have been shown entering the peritoneal cavity. This is the responsibility of the operator. If he visualizes correctly the axis of the uterus, he need rarely allow the needles to go out of bounds. Injury to arteries is rare because of the bluntness of the needles. Injuries to veins probably occur frequently. In a small number of cases bleeding from the site of a needle puncture has been sufficient to require vaginal packing. We have observed no pelvic hematoma.

Radiation injuries by this technique are due to the same causes as with any other, primarily a neglect of two fundamental principles,—the use of small doses of radiation over a protracted period of time and the law of inverse squares. In the application of external roentgen irradiation the importance of the small daily dose of roentgen rays is almost universally recognized. In discussions of radium technique, the importance of this principle is often ignored or deliberately minimized, the statement being made that the administration of powerful radium units for a short time produces the same effect as weak units for a long time provided that the milligram hours are the same. The recognition of the law of inverse squares is necessary when the uterine walls are thin or when the posterior fornix is so obliterated as to bring the radium in the cervix close to the rectum.

In our experience with this technique, there have been no bladder injuries. In fact, vesicovaginal fistula in a woman cured of cancer is rare with any technique. We have had one rectovaginal fistula; this was in a patient suffering from a lymphogranulomatous stricture of the rectum, complicating the carcinoma of the cervix.

Infection would seem to be a real danger when needles are plunged through a necrotic mass into the underlying tissue. In our experience severe infection occurred in one of the earliest cases when a laterally directed 6 cm. needle evidently punctured the obdurator fascia and caused a deep abscess of the upper thigh.

Clinical results are not presented in detail. All of the cases treated had extensive involvement of the parametrium and were classified as Stage III (League of Nations). We will only say that the immediate results are striking and unmistakably superior to those following our use of the intracavity technique.

CONCLUSION

Eighty-five to ninety per cent of cases of cancer of the cervix uteri are suitable for no other treatment than radiation.

By the use of the precision stereoscope the location of the radium units can be accurately determined, the distances between them measured and the dose calculated.

By this means a pattern of distribution of radium needles in the cervix and parametrium has been developed which delivers a minimum dose of 10,803 gamma roentgens to the areas indicated.

While there may be areas still receiving insufficient radiation from this particular pattern, a method is presented by which such deficiencies may be measured and corrected.

An important conclusion is that dosage should be expressed in terms of the amount of radiation reaching the various points at which it is aimed. Radium dosage expressed in milligram-hours and roentgen-ray dosage expressed in roentgens delivered to the skin is only partially informative.

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THE RELATION OF TRANSITIONAL CELL BUDS, GOLGI APPARATUS AND MITOCHONDRIA TO CARCINOMA OF THE BLADDER*

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THE treatment of tumors of the bladder continues to be a subject of much controversy. Most clinicians are aware of the fact that every patient suffering hematuria has a possible tumor of the bladder until it is proved otherwise. The efficacy of diagnostic urography and cystoscopy is appreciated by all. It still remains for the urologist to evaluate the various therapeutic measures to thereby determine the best treatment for each individual case. The subject of grading as introduced by Broders has helped to indicate the best treatment in may instances. At the present time, many physicians interested in this subject are beginning to appreciate still another consideration which will have to be correlated together with grading. We refer to the differentiation between pedunculated and non-pedunculated or flat vesical neoplasms. The experience of several investigators would indicate that a low grade non-pedunculated or flat neoplasm has proved to be more clinically malignant than the relatively high grade pedunculated type. After a careful study of each patient, the clinical urologist will have to select the type of treatment which his experience would indicate to be best.

Although vesical neoplasms show wide variations in appearance, we are all agreed they take origin from the transitional cell. The tendency to create new terms for variation in cellular architecture and form is confusing. This practice frequently complicates the picture first for the general reader, and second for many therapists who have a lesser knowledge of cytological pathology. When elaborate detailed classifications are thoroughly analyzed the terms are usually descriptive of a cellular arrangement, a condition which is dependent upon rate of cellular growth. This variation can be adequately classified by the application of grading. For this reason these tumors can conveniently be classified into two relatively sharp categories, one papillary, the other infiltrating.

The most frequent picture is one in which a small papillary growth is found. Usually this neoplasm is both pedunculated and low grade. The consensus as to the best form of treatment for such cases is transurethral fulguration with periodic cystoscopic re-examination of the bladder to detect the earliest recurrence or appearance of a new tumor. This policy has proved to be very satisfactory for the majority of patients. It is interesting to note that even this best known category of vesical neoplasm is being treated in several other ways. Transurethral fulguration with the insertion of one radon seed in the site of the pedicle has yet to be thoroughly evaluated. Similarly, the results of irradiating the recurrences from previously fulgurated tumors in this group also remain to be evaluated. Another well recognized category is that in which multiple papillary growths of relatively low grade are found. Evidence has accumulated which would indicate that these lesions, if they have not extended beyond the muscular layer, are perhaps adequately cared for by extensive fulguration down to the muscle layer through a suprapubic cystostomy and followed by the implantation of radon seed. Here, as in all types of treatment short of total cystectomy, frequent re-examination of the bladder for recurrences

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must necessarily be made to evaluate the results and to be on the alert for recurrent neoplasms. There are several workers in this field who advocate total cystectomy and ureterosigmoid transplantation for such cases. The efficacy of this plan of treatment yet remains to be accurately evaluated. Particularly for the flat infiltrating tumor one must endeavor to determine the extent of the infiltration. While at best such a study has definite limitations, the use of pneumocystography and bimanual examinations of the bladder under anesthesia has proved most informative to many. For the extratrigonal tumor that has not invaded beyond the muscle of the bladder, there are many who would advocate suprapubic segmental resections of the bladder. There are also those who recommend suprapubic fulguration with radon seed implantation and still others who consider total cystectomy with ureteral sigmoid transplantation. The latter two types of therapy have an equal number of enthusiasts for the trigonal infiltrating type of tumor. As with all other malignant neoplasms of the body, there are those cases with extensive infiltrating lesions both with and without metastases. This group is being treated by many urologists with roentgen therapy. As with all conditions in which numerous methods of therapy have been and are being advocated. the clinician is well aware of the fact that no treatment approximates being a panacea. At the present time, there remains for evaluation several additional therapeutic plans. We await learning the effect of the intravenous administration of radioactive materials on all the types of vesical neoplasm and the radon cystoscopic bomb.

If there is a condition in which the patience, judgment, and skill of the physician is to be tried, the management of vesical neoplasms ranks high on the list. Similarly, if there is a condition in which the value of early diagnosis has best proved itself, the management of vesical neoplasm stands foremost. It could well be said that the best treated bladder tumors are those in which the following sequence of events occur; the patient promptly consults his physician immediately after having suffered hematuria; the physician then promptly subjects the patient to urologic investigation. Such cooperation would serve well to remedy what most optimistic urologists deem a bad situation.

Unfortunately an accurate comparison of the four different methods of treatment, namely: fulguration, irradiation, segmental resection and total cystectomy, is impossible. This is due to wide variation in many factors. Some of these are wide variation in grade or cellular arrangement, age of patient, duration of lesion, variation in degree of perfection in each particular treatment method. These are but a few of the factors which make it impossible for an accurate comparison of the different methods of treatment.

When large series of all methods are analyzed the improved end results are usually due to a mastery of the technique applied. In spite of the increase in the average duration of life after the treatment of carcinoma by any of the four methods they must be considered to be inadequate.

The preceding enumeration and brief discussion of the present status of the treatment of carcinoma of the bladder shows that the outlook for this group of patients is relatively unsatisfactory. The purpose of this study has been to try to establish a better understanding of the biological behavior of these tumors. This was done with the hope of improving our present efficacy of treatment. The project consists first, of a study of the distribution and arrangement of the transitional cells; second, a cytological study of the Golgi apparatus and mitochondria found in malignant and non-malignant cells.

The presence of submucosal epithelial buds in the transitional cell covered tissues of the bladder was discovered by von Brunn in 1893. In a previous report he describes cell nests in the ureter in 38 out of 54 consecutive autopsy specimens. These areas are identified as transitional cell buds. They

are somewhat irregular in outline and imperfectly differentiated. Without entering into a discussion concerning the pathogenesis of submucosal cell nests, most observers are agreed that their appearance is very suggestive of susceptibility to activity of growth. In a previous report of 6 surgical specimens it was shown that the early changes which first involve the submucosal epithelial supporting tissue are inflammatory in type. This is followed by proliferation of the basal layer which eventually becomes papillary or infiltrating. These observations are in accord with the animal experiments in which carcinogenic hydrocarbons have been used to produce carcinoma.

The literature contains more than coincidental evidence that the anatomic distribution of these cell nests may be closely associated with the tumors we are discussing. The multiplicity of the epithelial buds in the renal pelvis, ureters and bladder is in accord with and very suggestive of the source of subsequently developed tumors. Frequently we destroy a bladder tumor only to find at a later examination that another has developed at a distant area. The removal of a kidney for papillary carcinoma of the pelvis is frequently followed by tumor development in the remaining ureter. When the kidney and ureter are removed for tumor of the kidney pelvis this is frequently followed by the development of bladder tumors. These factual clinical observations are very suggestive that the subsequent tumors probably develop from the epithelial cell nests described above. This course of events also suggests very forcefully that the stimulating substance which has caused the tumor growth is still active. It also suggests that the activation of these cell nests should be dependent upon changes in susceptibility to activation.

If this hypothesis be true (granted it has not been proved) how may these immature, imperfectly differentiated cell nests be rendered inactive or unsusceptible to growth? An approach may be by subjecting these cells to roentgen therapy. In support of this possibility 5 patients are presented. These patients were first seen in 1936. They all had low grade multiple papillomas of the bladder. Three were treated by roentgen therapy. This therapy established no appreciable change in the gross appearance of these tumors. They were subsequently destroyed by transurethral fulguration.

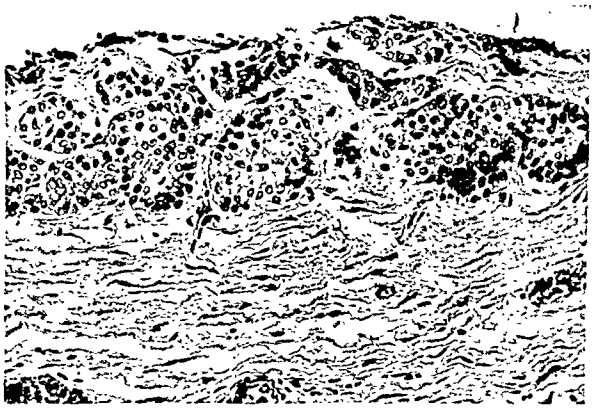


Fig. 1. This photomicrograph shows subtransitional cell buds. They may be single, double or multiple. Note the imperfect differentiation.

The frequent follow-up cystoscopic examinations have never revealed any evidence of recurrence. The other 2 patients were treated only by transurethral fulguration. These patients continue to develop new tumors in other areas in the bladder. These appeared at intervals ranging from three months to one year.

In 1945 after a discussion with Dr. E. P. Pendergrass we both agreed to give one of these patients a course of roentgen therapy over the bladder region. Except for three scattered small areas of bladder mucosal hyperemia the roentgen irradiated bladder has been free from recurrence. The other patient (non-irradiated one) continues to have new tumors develop. If we may consider the recurrences due to susceptible epithelium or susceptible epithelial nests, it may be assumed on hypothetical grounds that the roentgen therapy established changes in this epithelium which rendered the tissue less susceptible to carcinogenic irritation. Although the number of cases is

insufficient to draw definite conclusions the comparative difference in the clinical course is thought provoking.

With the hope of establishing a better understanding of the biological behavior of bladder tumors the Golgi apparatus and mitochondria have been studied. The original description by Golgi in 1898 was



Fig. 2. This is a section of a papillary carcinoma of the bladder, Grade 2. It shows the mitochondria with a lesser tendency to form a juxta-nuclear clump than has been seen in the normal control. Also the mitochondria appear to be more generally distributed throughout the cell.

followed by a voluminous array of literature. Although there are over two thousand publications about the Golgi apparatus most of the observations refer to findings in animal and plant life. Apparently no attention has been directed about the Golgi apparatus or mitochondria in human or animal bladder tumors. For purposes of definition it has been stated that the Golgi apparatus is a structure within cells which is blackened by osmic acid or by silver salts. It is distinct from finer articulate matter which may be similarly blackened. It is interpreted by different writers as fluid, semifluid, or solid, and is sharply separated from the surrounding cytoplasm so that its surfaces constitute interferences on which metals and a few dyes may be absorbed. It has been variously described as a series of canals or of vacuoles or as threads of lipoid material. In epithelial cells the usual position of the Golgi apparatus is in the cytoplasm distal to the nucleus, i.e. between the nucleus and free surface.

The mitochondria have also been studied intensively but with less divergence of view regarding their reality or their physical nature. They have been separated by centrifugation and subjected to chemical analysis. This has shown them to be a lipoprotein complex. They are subject to great variation in number and form, and most of the studies made on them have been empirical efforts to correlate these changes with previously known or new experimental conditions.

There were 15 bladder tumor specimens examined when possible normal or at least uninvolved tissue was obtained for controls. This preliminary study was recently reported in detail at the Fourth International Cancer Research Congress by the author, Hastings and Dalton, with the conclusion that several cases of the same tumor type have shown changes. Although that report referred to 290 operative specimens, only the vesical neoplasms will be referred to in this paper. The study showed differences from the normal pattern of the Golgi apparatus and in the number, size, and shape of the mitochondria. In certain instances changes have been found consistently in several tumors. The changes, as far as the Golgi apparatus is concerned, may be reversal, or extension away from the nuclei membrane; or increase in amount. The mitochondria show, in some instances, an increase in number and decrease in size. In others, the reverse is true.

Although the preliminary report on the Golgi apparatus and mitochondria studies does not warrant definite conclusions, the findings have stimulated our continued interest. We think the changes may prove of value in giving evidence as to relation between cytogenic changes and prognosis in cases of bladder papillomas.

During the past decade the vast accumu-

lation of information about chemical carcinogens has not been sufficiently emphasized. While it is not within the domain of this presentation to discuss carcinogenic substances it is possibly a cause of activating the transitional cell nests. Occupational carcinoma among chimney sweeps was recognized as early as 1775. The carcinogenic potency of the complex hydrocarbons has been described and proved experimentally. Physiological chemicals have been described as factors in the etiology of carcinoma. Although inconclusive chemically the potency of estrogenic substances has been proven to produce mammary carcinoma in carcinoma strains of mice. Bile acids, cholesterol, vitamin D and sex hormones are other physiological chemicals under inconclusive consideration. The detection of carcinoma of the urinary bladder among aniline dye workers has been known since 1895. The azo dyes have been proved to be carcinogenic agents. Since a systemic chemical basis for carcinoma is not without stimulating evidence, it seems that the immature buds may be the tissue susceptible to activation. The predominant clinical impression is that a patient who has a

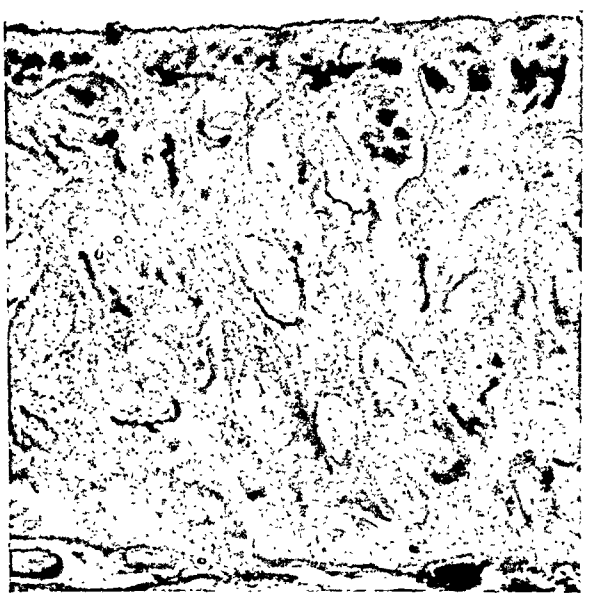


Fig. 3. Papillary carcinoma, Grade 1. This shows the reversal of the Golgi apparatus in the middle zone but with normal position in the more superficial and deep-lying cells.

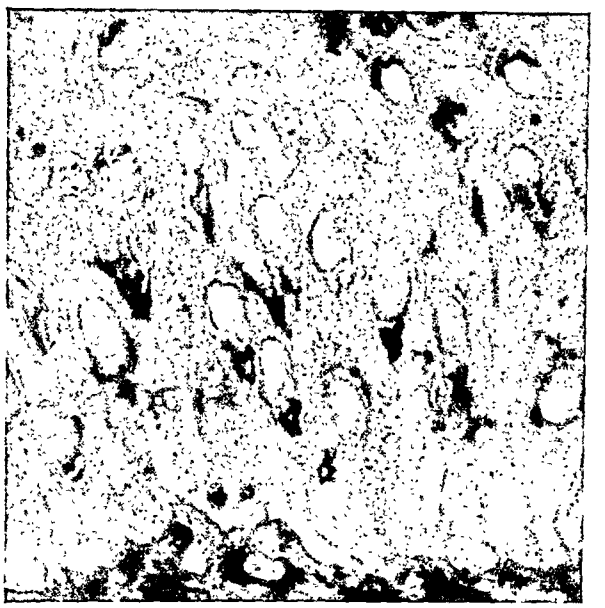


Fig. 4. Papillary carcinoma of the bladder, Grade 2. This shows more complete reversal of the Golgi apparatus. In the normal controls the Golgi apparatus was toward the surface.

tumor of either the renal pelvis, the ureter, or the bladder can have or may develop a tumor in any other of these locations. It is because of the keen appreciation of the association between these cell buds and the transitional cell type of tumor that one should consider a modification of the accepted policy of treatment. Any mechanism which could arrest or prevent the activation of cell buds should be very helpful.

Our present policy is to follow the radical surgical procedure with roentgen therapy over the remaining areas covered by transitional cell epithelium. This will include the entire remaining urinary tract. While the patients thus far studied are too few and sufficient time has not elapsed, the follow-up on bladder tumor patients treated this way has given increased courage to advise this postoperative therapy for patients with carcinoma of the renal pelvis, ureter, and bladder.

SUMMARY AND CONCLUSIONS

1. A simplified classification of bladder tumors is suggested.

2. The possible association between tran-

sitional cell nests and bladder papillomas has been discussed.

3. Postoperative roentgen therapy is advised for the remaining areas in the urinary system covered by transitional epithelium.

4. Differences from the normal pattern of the Golgi apparatus and in the number, size and shape of the mitochondria of normal cells have been noted in human bladder tumors.

5. The changes as far as the Golgi apparatus is concerned may be reversal with relation to the nucleus.

The studies of the Golgi apparatus and mitochondria were carried out at Jeanes Hospital, Philadelphia, under a grant from and in cooperation with the National Cancer Institute, Bethesda, Maryland.

The author wishes to thank Willard Hastings, M.D., and Albert J. Dalton, Ph.D., for their cooperation in this study.

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DISCUSSION

Dr. Eugene P. Pendergrass, Philadelphia, Pa. Dr. Bothe in his paper has commented briefly on the present method of treatment, some of the reasons for the poor results, and has described an approach which he hopes will lead to a better understanding of the biological behavior of bladder tumors. His investigations are concerned with the submucosal transitional cell buds, the Golgi apparatus, and mitochondria. My experience is such that I cannot discuss the relationship of the Golgi apparatus and mitochondria as it concerns the treatment or prognosis of bladder tumors, but I would like to reëmphasize a few points about vesical neoplasms.

Cancers of the bladder are commonly found in urologic practice, probably the most common. A large number are far advanced at the time treatment is instituted, because of the delay on the part of the practicing physician and most patients. Hematuria and vesical discomfort are the early symptoms in most instances. Carcinoma of the bladder is the most frequent cause of hematuria.

Tumors of the bladder are usually primary, although as Dr. Bothe said this morning, one may observe a tumor developing in the bladder following the removal of either a kidney or the kidney and ureter. The diagnosis can be made by cystoscopy and biopsy in most instances, the Papanicolaou test in some, bimanual palpation of the bladder by vagina or rectum under anesthesia to determine extravesical extension, the use of barium enemas, urographic and cystographic studies. In other words, what I am trying to say is that a complete diagnosis of the extent of the disease is important before any treatment is instituted.

It may be necessary in some instances to do an exploratory operation, and by exploratory operation I mean a laparotomy and cystotomy to determine whether the disease is confined to the bladder or has extended beyond.

I think Dr. Jewett's and Dr. Powell's slides that Dr. Bothe showed here this morning are a good illustration of the reason for that procedure.

Although the type of tumor is important, Jewett feels that the most important component is the extent to which the tumor has penetrated the bladder wall. The recent trend in the treatment of carcinoma of the bladder has been toward radical surgery. In a recent paper Marshall reported the experiences of Memorial Hospital in patients treated by irradiation, and he stated that they parallel the survival rate of cases reported by Welch and Nathanson in Boston; in other words, the life cycle was approximately 18.8 months.

If irradiation is employed—and it should be in many instances—one should not give so much irradiation that the effect will make the patient more uncomfortable then the discomfort experienced by the patient with the original lesion.

Dr. Bothe's concept that submucosal transitional nests of epithelium may be located in various parts of the bladder and predispose to new tumor formation, and that these nests should be irradiated, is most interesting. I am sure he meant to say that these submucosal cell nests occur not only in papillary tumors but also in carcinoma. If these transitional cells are susceptible to irradiation, one may at least prevent new growths.

Dr. Lenz has asked that I discuss the technique that we employ. Dr. Bothe in this work has, I believe, shown a very good reason why one should do postoperative irradiation even when segmental excision is carried out in these lesions. He also shows that even after cystotomy, one should consider doing postoperative

irradiation over the entire urinary tract; that is, the remaining kidneys and the ureter; and he bases that concept upon the study of cases showing these transitional cell nests distributed throughout the urinary tract. I do not know whether time is going to prove that this is a valuable procedure or not, and neither does Dr. Bothe. My own thought about it is that we should try this out and that we should anticipate that these transitional cell nests are susceptible to irradiation, and that the dosage should not be too large. My own thought is that 1,000 r should be delivered into the area of the kidney, pelvis, ureter, and residual bladder. These are done by daily dosages of 200 r, using fields that are adequate to cover those areas. Those fields measure about 15 by 16, or 15 by 20 cm.

DR. MAURICE LENZ, New York, N. Y. I wanted to know particularly whether you do this for carcinoma or only for papillomas.

DR. PENDERGRASS: I believe it should be done in carcinoma and papillomas of the bladder.

DR. LENZ: The same doses?

DR. PENDERGRASS: The same doses.

DR. GORDON E. RICHARDS, Toronto, Canada. Having had no experience in the methods proposed by Dr. Bothe, I really have no right to take part in the discussion, and the chief comments I have to offer are to suggest that the degree of imagination which has been put into this investigation is one that is very stimulating indeed. The study of cell rests throughout the body is not new, and their significance in connection with the later development of various types of malignant disease has frequently been referred to. Whether an analogy may be drawn between these cell rests occurring in the urinary tract and those occurring in the neck, I do not know. We think we have observed in branchiogenic carcinoma, which may occasionally be due to the development of carcinoma from cell rests, that the degree of sensitivity is higher than in ordinary or more commonly occurring secondary carcinoma from other types of lesions in the neck.

The amount of material which has been submitted for study by irradiation is too small, as Dr. Bothe mentioned, to justify any very sweeping conclusions, but if the statements made justify the suggestion offered, there should be opened up a field of considerable usefulness. Most of us, I think, have been moderately disappointed with the results of radiotherapy in bladder tumors, and are equally convinced that in the future prevention, where it is possible, is more important than attempts at cure, and this suggestion seems to offer that as a possibility.

The matter of technique has been covered by Dr. Pendergrass and I can only accept his statements with some reservations. I do not know whether 1,000 r would actually be sufficient unless it is regarded simply as an inhibitor. If we may reason from analogies elsewhere in the body, unless these cell rests are very radiosensitive, it would not be a sufficient dose to be destructive of carcinoma cells.

I would like to close by thanking Dr. Bothe for a very stimulating paper, which illustrates once again that often more progress is made by the detailed study of small groups than by more diffused studies of very large groups of cases. This has, to me, been a thought-provoking and stimulating paper from which I hope something useful will come in the future.

DR. MAURICE LENZ, New York, N. Y. The tumor dosage given prophylactically by Dr. Pendergrass to Dr. Bothe's cases of papilloma would, I believe, be inadequate to control bladder cancer. In a five to fifteen year follow-up study of 46 patients with cancer of the trigone treated by radium needles and cystostomy and reported in the AMERICAN JOURNAL of ROENTGENOLOGY AND RADIUM THERAPY, 1947, Vol. 58, pp. 486–491, we found clinical freedom from cancer in 16 per cent if the tumor dose was less than 8,000 gamma roentgens and nearly 33 per cent when it was over this amount.

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Thirty-first Annual Meeting: Atlantic City, 1949.

EDITORIAL

THE ANNUAL MEETING OF THE AMERICAN ROENTGEN RAY SOCIETY

AT THE Forty-ninth Annual Meeting of the American Roentgen Ray Society held in Chicago from September 14 to 17, 1948, radiology undeniably was placed on the highest pedestal of its comparatively short but very fruitful existence. The latest technical achievements and especially the breath-taking progress in the solution of some of the most intricate atomic phenomena were reflected amply in the subjects of a Scientific Program already embodying medical topics of rare and unusual interest.

The opening ceremony on Tuesday morning was an inspiring affair. After the Call to Order and Presentation of the Scientific Exhibit awards of the previous year's meeting by President J. Bennett Edwards, a cordial welcome was extended to the Society by Dr. J. Roscoe Miller, Dean of Northwestern University Medical School and President of the Chicago Medical Society. Dr. Vincent W. Archer, Chairman of the Executive Council, then in a heartfelt speech installed President-elect Lawrence Reynolds as the new President of the Society. Dr. Reynolds in an eloquent inaugural address vividly expressed the trend of the new developments which were to dominate the meeting. He humbly recalled how within one generation the "unicellular plant" originating in the basement of a hospital has grown into a modern department forming the keypoint at the "crossroads of the hospital corridors" from which "knowledge is disseminated in many directions to the benefit of the patient and to the advancement of medical progress." Then, after paying tribute to many illustrious members of the Society who actively participated in this great work, he reviewed the important role radiology played in the development of some allied sciences which figuratively speaking were "spawned" by radiology. Now, radiology finds itself at the threshold of a new era. "We have entered new fields of scientific investigation," said Dr. Reynolds, "involving to a great degree relativity rather than the absolute with which scientists were accustomed to deal and as a result of the application of atomic fission in medical research science has come to regard the human being as an exquisitely constructed physiochemical mechanism." But he also cautioned that "the headlong, almost untrammeled, advances of science in its search for truth has led us into perilous situations."

Following this thought-provoking address the members of the Society were treated to an excellent round table discussion on "Bronchogenic Carcinoma" by Drs. William M. Tuttle, John R. McDonald, William E. Adams, and Leo G. Rigler. The large number of written questions placed from the floor attested to the popularity of this discussion.

The afternoon session was taken up entirely by a symposium on "Congenital Heart Disease." The clinical, roentgenographic and surgical aspects were presented by men with great authority in their respective fields. Considerable attention was paid to cardiovascular angiography, and Dr. Wendell G. Scott presented the so-called tautograph which serves for the automatization of the roentgenographic technique in cardiovascular and angiographic examinations. This apparatus is capable of making rapid serial roentgeno-

grams of short exposure, thus avoiding excessive irradiation of the patient. Dr. C. Rollins Hanlon in discussing the surgical aspect gave a statistical analysis of the results obtained in 650 cases of congenital cyanotic heart disease at the Johns Hopkins Hospital. He also showed an excellent moving picture in colors illustrating the operative technique and some unusual operative findings.

On Wednesday morning another interesting panel discussion on the "Diagnosis and Treatment of Diseases of the Chest" was given by members of the regular weekly chest conference of the Hospital of the University of Pennsylvania, with Dr. Eugene P. Pendergrass acting as moderator. The participants were Drs. Julian Johnson, Simon Leopold, Joseph Atkins, Julius Comroe and Robert P. Barden, representing the surgeon, internist, bronchoscopist, physiologist and radiologist on the panel. Mimeographed résumés of the cases discussed were distributed to the audience so that the problems involved could be more easily followed. The program was conducted in the same manner as the regular hospital conference, emphasizing the great value of group consultation.

The interest in the roentgen study of the chest is so great that the first half of the afternoon session was also devoted to topics on this subject. Dr. A. C. Christie gave a masterful paper on the "Medical and Roentgenological Aspects of Mass Chest Surveys," with particular emphasis on the results of the Washington Survey with respect to the percentage and type of tuberculous and other lesions discovered, and the value and type of subsequent roentgen examinations. Other papers were: "The Angiocardiographic Diagnosis of Syphilitic Aortitis" given by Dr. Charles Dotter; "The Fate of Oil Particles in the Lung and Their Relationship to the Development of Bronchiogenic Carcinoma; a Roentgenological and Pathological Study" by Dr. L. R. Sante; "Hemosiderosis of the Lung Due to Mitral Disease; a Report of Six Cases Simulating Pneumoconiosis" delivered by Dr. Edwin L. Lame and "The Role of Nitrogen Mustard as an Adjunct to Roentgen Therapy of Malignant Diseases" presented by Dr. Bernard Roswit.

The second half of the Wednesday afternoon session was given over to a symposium of the utmost importance as regards future possibilities in the construction of more sensitive roentgenoscopic units. The symposium dealt with the "Intensification of the Roentgenoscopic Screen" but in the discussion that followed the progress in the design of "the scanning roentgen-ray tube" was also considered. As an introduction, Dr. W. Edward Chamberlain gave a brief review of the "Present Day Roentgenoscopes and Their Deficiencies." He stated that because of the low visual acuity which an observer has at the brightness levels occurring during roentgenoscopy, often roentgenographic procedures are preferred. Dr. Ralph E. Sturm then analyzed the "Fundamental Limitations of Screen Intensifying Systems" and showed that at low levels of illumination the performance of all optical devices (including the eye) is largely limited by statistical fluctuations in the number of light photons reaching the device during the observation of an event. He also discussed the magnitude of these fluctuations existing under ordinary roentgenoscopic conditions and under conditions likely to occur with various intensifying devices, such as the Langmuir image tube, the Moon scanning system and the Coltman image tube. In the next paper Dr. John W. Coltman presented in detail his "New Image Tube for Brightening the Roentgenoscopic Screen." The arrangement permits the light from a fluorescent screen to eject electrons from a transparent photoelectric surface, accelerating these electrons and bombarding a second fluorescent screen with them. The new tube will brighten the image 500 times. Finally, Drs. Russell H. Morgan and John F. Roach described the "Clinical Potentialities of Screen Intensification." A tube that has a gain of approximately 300 times was tested in the Department of Roentgenology

at the Johns Hopkins Hospital for the past few months. The detail of the anatomic structures appeared four times as sharp as that provided by conventional roentgenoscopes. In the discussion that followed Dr. Robert J. Moon gave a brief account of the latest progress in the construction of a "scanning roentgen-ray tube" which forms part of his amplification system reported in the June, 1948, issue of this JOURNAL. The entire symposium was very appropriately under the chairmanship of Dr. Russell H. Morgan who has contributed so notably toward the improvement of roentgenologic apparatus during the past decade. The essayists were honored by the presence in the audience of Dr. W. D. Coolidge.

An appropriate climax of this very profitable day was the Caldwell Lecture which was delivered in the evening by Dr. B. R. Kirklin, a distinguished former President of the Society. The introduction was made by Dr. Lyell C. Kinney in his customary polished style. Dr. Kirklin spoke on "Graduate Education in Radiology," a subject for which he is particularly equipped considering his long experience in the dual capacity of Director of the Instruction Courses of the American Roentgen Ray Society and Secretary of the American Board of Radiology. His words carried great authority and the suggestions made will undoubtedly have an outstanding part in fashioning programs for the best training of future radiologists. At the close of the lecture the Caldwell Medal was presented in a few well chosen words to Dr. Kirklin by President Reynolds.

On Thursday a splendid symposium on "Radiobiology," presided over by Dr. H. M. Parker, constituted the highlight of events. This symposium occupied the entire morning session and half of the afternoon session. Its participants were the leading scientists in their respective fields, coming from all sections of the country. The subjects discussed were not only of unsurpassed interest in relation to radiology but they were also of the utmost timeliness as concerns their general practical importance. They included: "Findings on Total Body Radiation from Nuclear Sources" by Dr. Shields Warren; "Recent Developments in the Study of Radiation Effects on the Hematopoietic System" by Dr. Leon O. Jacobson; "The Effect of Ionizing Radiations on Enzymes and Proteins" by Dr. E. S. Guzman Barron; "Radiobiological Additivity of Various Ionizing Radiations" by Dr. Raymond E. Zirkle; "Some Biologic Effects of Long Continued Irradiation" by Dr. Egon Lorenz; "The Metabolic Properties of the Fission Products and Actinide Elements" by Dr. Joseph G. Hamilton; "The Influence of Radiation Exposure on Length of Life of Laboratory Animals" by Dr. Robert D. Boche, with a very competent general discussion by Dr. Edith H. Quimby and Dr. Paul Aebersold.

The second half of the Thursday afternoon session was devoted to papers dealing with the physical and clinical problems of radiation therapy. Dr. G. Failla and Dr. H. H. Rossi discussed the "Dosimetry of Ionizing Particles." The difficulties in measuring tissue doses for beams of various ionizing particles (electrons, protons) and neutrons in terms of r were examined. The opinion was expressed that an ionization chamber in which both the wall material and the gas are tissue equivalent may serve a good purpose. Dr. Lauriston S. Taylor analyzed the "Problems of Dosage Measurements for Radiations Above 1 Mev.," and he arrived at the conclusion that in the range of high energies the r is not sufficiently flexible, necessitating complete revision of the dosage measurement. In another paper Dr. G. D. Adams, representing a group of seventeen men working under the guidance of Dr. Donald W. Kerst reported on the "Techniques for Application of the Betatron to Therapy." He described in particular the procedure which was used in treating a case of glioblastoma with 22 mev. The day's program was concluded with two papers on therapy, one by Drs. T. Leucutia and James C. Cook on "Malignant Degeneration of Benign Giant Cell Tumor of Bone," and

the other by Dr. Bernard P. Widmann on "Cancer of the Lip" in which he reviewed more than 300 cases treated over a period of twenty-five years.

There was a group of six very interesting papers on Friday morning. These included the following: "Relative Incidence of Bone Lesions, Including Fractures" by Dr. Sherwood Moore; "The Roentgen Examination of the Cervical Spine" by Drs. Joseph C. Bell and James B. Douglas; "The Relation of Therapeutic Radiology to Clinical Medicine" by Dr. A. U. Desjardins; "Intravenous Urography in the Study of Vesical Neck Obstruction" by Dr. W. J. Engel; "Deformities of the Bladder Secondary to Ureteral Stone" by Drs. Harold O. Peterson and Barnard Hall, and "The Early Diagnosis of Gastric Cancer by Photofluorography" by Drs. John F. Roach, Robert D. Sloan, and Russell H. Morgan. On Friday afternoon the following seven excellent papers were given: "The Occurrence of Gastric Ulcer in Diaphragmatic Hernia" by Drs. Glenn F. Miller and Howard P. Doub; "Gastrointestinal Food Hypersensitivity as Shown by the Roentgen Ray" by Drs. E. J. Tallant, Frederick Urbach and Hugh A. O'Neill; "A Rapid Method of Roentgenologic Examination of the Small Intestine" by Drs. Sydney Weintraub and Robert G. Williams; "Subacute (Pseudotuberculous) Thyroiditis and Its Treatment" by Drs. John D. Osmond, Jr., and U. V. Portmann; "Some Partial and Complete Obstructions of the Respiratory Tract in the Newborn Due to Tracheobronchial Malformations" by Dr. W. A. Evans; "The Time Factor in Cerebral Angiography and the Automatic Seriograph" by Drs. J. M. Sanchez-Perez and R. A. Carter, and "Bone Involvement in Cryptococcosis (Torulosis)" by Dr. Vincent P. Collins. It is impossible in this limited space to give even an abbreviated account of the many important topics embodied in these papers and the fine thought-provoking discussions that followed. Suffice it to say that when the end of the day came, a large audience was still present to witness the ringing down of the final curtain on the Forty-ninth Annual Meeting.

The other aspects of the meeting were equally successful. The Instruction Courses which this year were so ably organized by Dr. Harry M. Weber were exceedingly well attended. The Scientific Exhibits arranged by the Committee under the Chairmanship of Dr. Wilbur P. Bailey were most attractive and enjoyed great popularity. The Technical Exhibits were splendidly assembled and disposed. The many new apparatus, instruments and devices displayed created unusual interest and the various exhibitors gave generously of their time in furnishing the necessary explanations.

The social program deserves special mention. The Annual Golf Tournament arranged by the local Chairman, Dr. Warren W. Furey, was held Monday at the Bunker Hill Golf Club, Niles, Illinois. It consisted of luncheon, an eighteen hole match for the Willis F. Manges Trophy and the Exhibitors' Trophy, and an excellent dinner. On Wednesday evening, following the Caldwell Lecture, there was a delightful party, at which the Chicago Roentgen Society was host. The Annual Banquet on Thursday evening was a gala affair, with some unusual entertainment, splendid music, and gaiety and dancing lasting into the early morning hours. The Society is grateful to Dr. R. A. Arens, and his Committee on Local Arrangements and to Mrs. R. A. Arens and her Ladies' Committee for their competent and efficient work.

To the executive staff and personnel of the Palmer House the Society desires to express its thanks for the capable management of the meeting and the many courtesies extended to the members and guests.

It was an excellent meeting in every sense of the word. Dr. Reynolds and his Program Committee can derive pleasure and satisfaction in the knowledge that their untiring efforts have been rewarded with splendid success. T.L.

SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

Items for this section solicited promptly after the events to which they refer

MEETINGS OF ROENTGEN SOCIETIES*

UNITED STATES OF AMERICA

AMERICAN ROENTGEN RAY SOCIETY
Secretary, Dr. H. Dabney Kerr, University Hospital, Iowa City, Iowa. Annual meeting: Netherland Plaza Hotel, Cincinnati, Ohio, Oct. 4–7, 1949.

AMERICAN RADIUM SOCIETY
Secretary, Dr. H. F. Hare, 605 Commonwealth Ave., Boston, Mass. Annual meeting: Atlantic City, 1949.

RADIOLOGICAL SOCIETY OF NORTH AMERICA
Secretary, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N. Y. Annual meeting: Hotels Fairmont and Mark Hopkins. San Francisco, Calif., Dec. 5–10, 1948.

AMERICAN COLLEGEOF RADIOLOGY
Executive Secretary, William C. Stronach, 20 N. Wacker Drive, Chicago 6. Annual meeting: 1949, to be announced.

SECTION ON RADIOLOGY, AMERICAN MEDICAL ASSOCIATION
Secretary, Dr. U. V. Portmann, Cleveland Clinic, Cleveland, Ohio, Annual Meeting: 1949, to be announced.

ALABAMA RADIOLOGICAL SOCIETY
Secretary, Dr. C. S. Stickley, 515 Bell Bldg., Montgomery, Ala. Next meeting time and place of Alabama State Medical Association.

ARKANSAS RADIOLOGICAL SOCIETY
Secretary, Dr. Fred Hames, 511 National Bldg., Pine Bluff, Ark. Meets every three months and also at time and place of State Medical Association.

BROOKLYN ROENTGEN RAY SOCIETY
Secretary, Dr. A. H. Levy, 1354 Carroll St., Brooklyn 13, N. Y. Meets monthly on fourth Tuesday, October to April.

BUFFALO RADIOLOGICAL SOCIETY
Secretary, Dr. Mario C. Gian, 610 Niagara St., Buffalo, N. Y. Meets second Monday evening each month, October to May inclusive.

CENTRAL NEW YORK ROENTGEN RAY SOCIETY
Secretary, Dr. Dwight V. Needham, 608 E. Genesee St., Syracuse, N. Y. Three meetings a year January, May, November.

CENTRAL OHIO RADIOLOGICAL SOCIETY
Secretary, Dr. Paul D. Meyer, Grant Hospital, Columbus, Ohio. Meets at 6:30 P.M. on second Thursday of October, December, February, April, and June at Seneca Hotel, Columbus, Ohio.

CHICAGO ROENTGEN SOCIETY
Secretary, Dr. John H. Gilmore, 720 N. Michigan Ave., Chicago 11, Ill. Meets second Thursday of each month October to April inclusive at the Palmer House.

CINCINNATI RADIOLOGICAL SOCIETY
Secretary, Dr. Eugene L. Saenger, 735 Doctors Bldg., Cincinnati 2, Ohio. Meets last Monday of each month, September to May, inclusive.

CLEVELAND RADIOLOGICAL SOCIETY
Secretary, Dr. George L. Sackett, 10515 Carnegie Ave. Cleveland 6, Ohio. Meetings at 6:30 P.M. on fourth Monday of each month from October to April.

DALLAS-FORT WORTH ROENTGEN STUDY CLUB
Secretary, Dr. X. R. Hyde, Medical Arts Bldg., Fort Worth, Texas. Meets in Dallas on odd months and in Fort Worth on even months, on third Monday, 7:30 P.M.

DENVER RADIOLOGICAL CLUB
Secretary, Dr. Mark S. Donovan, 306 Majestic Bldg., Denver 2, Colo. Meets third Friday of each month at Department of Radiology, Colorado School of Medicine.

DETROIT ROENTGEN RAY AND RADIUM SOCIETY
Secretary, Dr. E. R. Witwer, Harper Hospital. Meets monthly on first Thursday from October to May, at Wayne County Medical Society Building.

FLORIDA RADIOLOGICAL SOCIETY
Secretary, Dr. F. K. Hurt, Riverside Hospital, Jacksonville, Fla. Meets twice annually, in the spring with the annual State Society meeting, and in the fall.

GEORGIA RADIOLOGICAL SOCIETY
Secretary, Dr. Robert Drane, DeRenne Apartments, Savannah, Ga. Meets in mid-winter and at annual meeting of Medical Association of Georgia in the spring.

HOUSTON X-RAY CLUB
Secretary, Dr. Curtis H. Burge, 3020 San Jacinto St., Houston 4, Texas. Meets fourth Monday each month.

RADIOLOGICAL SOCIETY OF KANSAS CITY
Secretary, Dr. Arthur B. Smith, 800 Argyle Bldg., Kansas City, Mo. Meets third Thursday of each month.

ILLINOIS RADIOLOGICAL SOCIETY
Secretary, Dr. Wm. DeHollander, St. John's Hospital, Springfield, Ill. Meets three times a year.

INDIANA ROENTGEN SOCIETY
Secretary, Dr. William M. Loehr, 712 Hume-Mansur Bldg., Indianapolis 4. Meets second Sunday in May.

IOWA X-RAY CLUB
Secretary, Dr. Arthur W. Erskine, 326 Higley Bldg., Cedar Rapids, Iowa. Luncheon and business meeting during annual session of Iowa State Medical Society. *Special meetings by announcement.*

KANSAS RADIOLOGICAL SOCIETY
Secretary, Dr. Anthony F. Rossitto, Wichita Hospital, Wichita, Kansas. Meets annually with the State Medical Society.

KENTUCKY RADIOLOGICAL SOCIETY
Secretary, Dr. W. C. Martin, 321 W. Broadway, Louisville. Meets annually in Louisville on first Saturday in Apr.

LONG ISLAND RADIOLOGICAL SOCIETY
Secretary, Dr. Marcus Wiener, 1430-48th St., Brooklyn, N. Y. Meets Kings County Med. Soc. Bldg. monthly on fourth Thursday, October to May, 8:45 P.M.

LOS ANGELES RADIOLOGICAL SOCIETY
Secretary, Dr. Moris Horwitz, 441 No. Camden Drive, Beverly Hills, Calif. Meets second Wednesday each month at Los Angeles County Medical Assn. Building.

LOUISIANA RADIOLOGICAL SOCIETY
Secretary, Dr. J. R. Anderson, 1130 Louisiana Ave., Shreveport. Meets annually during Louisiana State Medical Society Meeting.

LOUISVILLE RADIOLOGICAL SOCIETY
Secretary, Dr. E. L. Pirkey, Louisville General Hospital, Louisville 2, Ky. Meets monthly on second Friday at Louisville General Hospital.

MICHIGAN ASSOCIATION OF ROENTGENOLOGISTS
Secretary, Dr. R. D. McDuff, 220 Genesee Bank Bldg., Flint 3, Mich.

MILWAUKEE ROENTGEN RAY SOCIETY
Secretary, Dr. C. A. H. Fortier, 231 W. Wisconsin Ave.,

* Secretaries of societies not here listed are requested to send the necessary information to the Editor.

Milwaukee, Wis. Meets monthly on second Monday at University Club.

Minnesota Radiological Society
Secretary, Dr. Chauncey N. Borman, 802 Medical Arts Bldg., Minneapolis 2, Minn. Two meetings yearly, one at time of Minnesota State Medical Association the other in the fall.

Nebraska Radiological Society
Secretary, Dr. Ralph C. Moore, Nebraska Methodist Hospital, Omaha 3, Nebr. Meets third Wednesday of each month, at 6 P.M. at either Omaha or Lincoln.

New England Roentgen Ray Society
Secretary, Dr. George Levene, Massachusetts Memorial Hospitals, Boston, Mass. Meets monthly on third Friday, Boston Medical Library.

New Hampshire Roentgen Ray Society
Secretary, Dr. A. C. Johnston, Elliott Community Hospital, Keene, N. H. Meets four to six times yearly.

New York Roentgen Society
Secretary, Dr. Ramsay Spillman, 115 East 61st St., New York City. Meets monthly on third Monday, New York Academy of Medicine, at 8:30 P.M.

North Carolina Radiological Society
Secretary, Dr. J. E. Hemphill, 323 Professional Bldg., Charlotte 2, N. C. Meets in May and October.

North Dakota Radiological Society
Secretary, Dr. C. O. Heilman, 807 Broadway, Fargo. Meetings held by announcement.

Northern California Radiological Club
Secretary, Dr. C. E. Grayson, Medico-Dental Bldg., Sacramento 14, Calif. Meets at dinner last Monday, every second month, except June, July and August. Next meeting Sept. 27, 1948.

Ohio State Radiological Society
Secretary, Dr. Carroll C. Dundon, 2065 Adelbert Road, Cleveland 6, Ohio.

Oklahoma State Radiological Society
Secretary, Dr. W. E. Brown, Tulsa, Okla. Three regular meetings annually.

Oregon Radiological Society
Secretary, Dr. William Y. Burton, 242 Medical Arts Bldg., Portland 5, Oregon. Meets monthly 2nd Wednesday, 8:00 P.M., Library of University of Oregon Medical School.

Orleans Parish Radiological Society
Secretary, Dr. Joseph V. Schlosser, Charity Hospital, New Orleans 13, La. Meets first Tuesday of each month.

Pacific Northwest Radiological Society
Secretary, Dr. S. J. Hawley, 1320 Madison St., Seattle 4, Wash. Meets annually in May.

Pacific Roentgen Society
Secretary, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association.

Pennsylvania Radiological Society
Secretary, Dr. J. M. Converse, 416 Pine St., Williamsport.

Philadelphia Roentgen Ray Society
Secretary, Dr. Arthur Finkelstein, Graduate Hospital, 19th and Lombard St. Meets first Thursday each month October to May, at 8:00 P.M., in Thomson Hall, College of Physicians.

Pittsburgh Roentgen Society
Secretary, Dr. R. P. Meader, 4002 Jenkins Arcade Pittsburgh 22, Pa. Meets 6:30 P.M. at Webster Hall Hotel on second Wednesday each month, October to May inclusive.

Queens Roentgen Ray Society
Secretary, Dr. J. E. Goldstein, 88-29 163rd St., Jamaica 3, N. Y. Meets fourth Monday of each month except during the summer.

Radiological Section, Baltimore Medical Society
Secretary, Dr. Harry A. Miller, 2452 Eutaw Place, Baltimore. Meets third Tuesday each month, September to May.

Radiological Section, Connecticut Medical Society
Secretary, Dr. Robert M. Lowman, Grace-New Haven Community Hospital, New Haven 11. Meets bimonthly second Thursday, at place selected by Secretary.

Radiological Section, District of Columbia Medical Society
Secretary, Dr. A. A. J. Den, 1801 K St., N. W., Washington, D. C. Meets Medical Society Auditorium, third Thursday, January, March, May, October at 8:00 P.M.

Radiological Section, Southern Medical Association
Secretary, Dr. Roy G. Giles, Temple, Texas.

Radiological Society of New Jersey
Secretary, Dr. Raphael Pomeranz, 31 Lincoln Park, Newark, N. J. Meets annually at time and place of State Medical Society. Mid-year meetings at place chosen by president.

Rochester Roentgen Ray Society, Rochester, N. Y.
Secretary, Dr. Murray P. George, Strong Memorial Hospital. Meets monthly on third Monday from October to May, inclusive, 8 P.M. at Strong Memorial Hospital.

Rocky Mountain Radiological Society
Secretary, Dr. Maurice D. Frazer, 1037 Stuart Bldg., Lincoln, Nebr.

St. Louis Society of Radiologists
Secretary, Dr. Edwin C. Ernst, Beaumont Medical Building, St. Louis, Mo. Meets fourth Wednesday of each month, except June, July, August, and September.

San Diego Roentgen Society
Secretary, Dr. R. F. Niehaus, 1831 Fourth Ave., San Diego, Calif. Meets monthly, first Wednesday at dinner.

Section on Radiology, California Medical Association
Secretary, Dr. D. R. MacColl, 2007 Wilshire Blvd., Los Angeles 5, Calif.

Section on Radiology, Illinois State Medical Society
Secretary, Dr. Edwin L. Rypins, 427 N. Main St., Bloomington, Ill.

Shreveport Radiological Club
Secretary, Dr. R. W. Cooper, Charity Hospital, Shreveport, La. Meets monthly on third Wednesday, at 7:30 P.M., September to May inclusive.

South Carolina X-Ray Society
Secretary, Dr. T. A. Pitts, Baptist Hospital, Columbia, S. C. Meets in Charleston on first Thursday in November, also at the time and place of South Carolina State Medical Association.

Tennessee Radiological Society
Secretary, Dr. J. M. Frère, 707 Walnut St., Chattanooga, Tenn. Meets annually at the time and place of the Tennessee State Medical Association.

Texas Radiological Society
Secretary, Dr. R. P. O'Bannon, 650 Fifth Ave., Fort Worth 4, Texas.

University of Michigan Department of Roentgenology Staff Meeting
Meets each Monday evening from September to June, at 7 P.M. at University Hospital.

University of Wisconsin Radiological Conference
Secretary, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis. Meets first and third Thursdays 4:00 to 5:00 P.M., September to May inclusive. Room 203, Service Memorial Institute, 426 N. Charter St., Madison.

Utah Radiological Conference
Secretary, Dr. Henry H. Lerner, School of Medicine, University of Utah, Salt Lake City 1. Meets 1st and 3rd Thursdays monthly from 7:30 to 10 P.M., Salt Lake County General Hospital, September to June.

Utah State Radiological Society
Secretary, Dr. M. Lowry Allen, Judge Bldg., Salt Lake City 1, Utah. Meets third Wednesday in September, November, January, March and May.

Virginia Radiological Society
Secretary, Dr. P. B. Parsons, Norfolk General Hospital, Norfolk, Va. Meets annually in October.

Washington State Radiological Society
Secretary, Dr. Homer V. Hartzell, 310 Stimson Bldg., Seattle 1, Wash. Meets fourth Monday each month, October through May, College Club, Seattle.

X-Ray Study Club of San Francisco
Secretary, Dr. Ivan J. Miller, 49 Fourth St., San Francisco 3. Meets monthly on third Thursday at 7:45 P.M., January to June at Lane Hall, Stanford University Hospital, and July to December at Langley Porter Clinic, University of California Hospital.

Cuba

Sociedad de Radiología y Fisioterapia de Cuba
President, Dr. J. Manuel Viamonte, Hospital Mercedes, Habana, Cuba. Meets monthly in Habana.

Mexico

Sociedad Mexicana de Radiologia y Fisioterapia
General Secretary, Dr. D. P. Cossio, Marsella No. 11, Mexico, D. F. Meets first Monday of each month.

British Empire

British Institute of Radiology Incorporated with the Roentgen Society
Medical Members' meeting held monthly on third Friday at 2:30 p.m. and Ordinary Meeting at same time on following Saturday, October to May, 32 Welbeck St., London, W.1.

Faculty of Radiologists
Honorary Secretary, Dr. J. F. Bromley, 45, Lincoln's Inn Fields, London, W.C.2, England.

Section of Radiology of the Royal Society of Medicine (Confined to Medical Members)
Meets third Friday each month at 4:45 p.m. at the Royal Society of Medicine, 1 Wimpole St., London.

Canadian Association of Radiologists
Honorary Secretary, Dr. E. M. Crawford, 2100 Marlowe Ave., Montreal 28, Que. Meetings January and June.

Section of Radiology, Canadian Medical Association
Secretary, Dr. C. M. Jones, Inglis St., Ext. Halifax, N. S.

Société Canadienne-Francaise d'Electrologie et de Radiologie Médicales
Secretary, Dr. Origéne Dufresne, 4120 Ontario St., East, Montreal, P. Q.

Australian and New Zealand Association of Radiologists
Honorary Secretary, Dr. Alan R. Colwell, 135 Macquarie St., Sydney, N.S.W.
Honorary Secretaries, State Branches:
New South Wales, Dr. E. W. Frecker, 135 Macquarie St., Sydney.
Victoria, Dr. T. L. Tyrer, 3 Lockerbie Court, East St. Kilda.
Queensland, Dr. J. Adam, 131 Wickham Terrace, Brisbane.
South Australia, Dr. B. C. Smeaton, 178 North Terrace, Adelaide.
Western Australia, Dr. A. M. Nelson, 179-B St. Georges Terrace, Perth.
New Zealand, Dr. E. G. Lynch, 12 Bolton St., Wellington.

South America

Sociedad Argentina de Radiologia
Secretary, Dr. Guido Gotta, Buenos Aires, Argentina. Meetings are held monthly.

Sociedade Brasileira de Radiologia Medica
Secretary, Dr. Nicola Caminha, Av. Mem de Sa, Rio de Janeiro, Brazil. Meets monthly, except during January, February and March.

Sociedade Brasileira de Radioterapia
Secretary, Dr. Andrelino Amaral, Av. Brigadeiro Luiz Antonio, 644, São Paulo, Brazil. Meets monthly on second Tuesday at 9 p.m. in São Paulo at Av. Brigadeiro Luiz Antonio, 644.

Sociedad Peruana de Radiologia
Secretary, Dr. Julio Bedoya Paredes, Apartado, 2306, Lima, Peru. Meets monthly except during January, February and March, at Asociación Médica Peruana "Daniel A Carrión," Villalta, 218, Lima.

Sociedad de Radiologica, Cancerologia y Fisica Medica del Uruguay
Secretary, Dr. Arias Bellini.

Continental Europe

Société Belge de Radiologie
General Secretary, Dr. S. Masy, 111 Avenue des Alliés, Louvain, Belgium. Meets monthly, second Sunday at Maison des Médecins, Brussels.

Ceskoslovenská společnost pro röntgenologii a radiologii v Praze
Secretary, Dr. Roman Bláha, Praha XII, stát. nemocnice, Czechoslovakia. Meets monthly except during July, August, and September. Annual general meeting.

Polish Society of Radiology
Secretary, Dr. L. Zgliczynski, 59 Nowogrodzka St., Warsaw, Poland. Next meeting, Krakow, June 2 and 3, 1949.

Gdansk Section, Polish Society of Radiology
Secretary, Dr. A. Smigielska, Akademia Lekarska, Gdansk. Meets monthly last Sunday at 10.30, X-Ray Dept., Akademia Gdansk.

Warsaw Section, Polish Society of Radiology
Secretary, Dr. L. Zgliczynski, 59 Nowogrodzka St., Warsaw, Poland. Meets monthly.

Societatea Romana de Radiologie si Electrologie
Secretary, Dr. Oscar Meller, Str. Banual Mărăcine, 30, S. I., Bucuresti, Roumania. Meets second Monday in every month with the exception of July and August.

All-Russian Roentgen Ray Association, Leningrad. USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.
Secretaries, Drs. S. A. Reinberg and S. G. Simonson. Meets annually.

Leningrad Roentgen Ray Society
Secretaries, Drs. S. G. Simonson and G. A. Gusterin. Meets monthly, first Monday at 8 o'clock, State Institute of Roentgenology and Radiology, Leningrad.

Moscow Roentgen Ray Society
Secretaries, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky. Meets monthly, first Monday, 8 p.m.

Scandinavian Roentgen Societies
The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association.

Sociedad Espanola de Radiologia y Electrologia
Secretary, Dr. J. Martin-Crespo, Fuencarral, 7. Madrid, Spain. Meets monthly in Madrid.

Schweizerische Röntgen-Gesellschaft (Société Suisse de Radiologie)
President, Dr. H. E. Walther, Gloriastr. 14, Zürich, Switzerland.

Societa Italiana di Radiologia Medica
Secretary, Prof. Mario Ponzio, Ospedale Mauriziano Torino, Italy. Meets biannually.

SCIENTIFIC EXHIBIT

The Scientific Exhibit, as is the tradition, formed an interesting and very valuable part of the Forty-Ninth Annual Meeting of the American Roentgen Ray Society, which was held in Chicago, Illinois, September 14–17, 1948. President Reynolds and his Program Committee had arranged the schedule of the meeting in such a manner that ample time was given for the study of the exhibits. The Scientific Exhibits Committee, under the Chairmanship of Dr. Wilbur Bailey cooperated in this by furnishing space accommodation next to the assembly hall. The exhibitors themselves contributed to the success by giving generously of their valuable time in explaining the purport and detailed arrangement of their exhibits. The attractiveness of the display and the scientific interest of the subjects chosen as well as the timeliness of some of the atomic energy topics were stimulating and undoubtedly accounted for the popularity of the exhibits this year. The Committee on Awards expressed its thanks to the Surgeon General of the Navy, to the Surgeon General of the Army and to the Chief Medical Director of the Veterans Administration for the excellent exhibits from these services. The Committee awarded to the exhibits as indicated in the following description, the Silver Medal, the Bronze Medal and four Certificates of Merit.

One of the most interesting and instructive exhibits was that by Wendell G. Scott, M.D., and Sherwood Moore, M.D., Mallinckrodt Institute of Radiology and Washington University School of Medicine, St. Louis, Missouri, entitled "Automatization of Angiocardiography by the Tautograph." The exhibit was the description of equipment which was devised to automatize cardiovascular angiography and other related roentgenographic procedures. The purpose was to develop a system by which it would be possible to make repeated, short roentgenographic exposures using the Potter-Bucky diaphragm. The tautograph was demonstrated along with details of construction and of the electric circuits that are employed. The apparatus offers a new principle in rapid serial roentgenography by utilizing a chain conveyor system for standard cassettes, by the incorporation of a reciprocating Potter-Bucky grid and by a complete automatization of the entire equipment. Normal angiograms as well as some pathologic angiograms as, for example, cor biatriatum triloculare, Eisenmenger complex, etc., were used to illustrate the method. A cinematographic film was also projected showing the actual method of procedure. This exhibit was given a Certificate of Merit by the Committee on Awards.

"Renal Pathology" was the title of an exhibit by Cesare Gianturco, M.D., Carle Hospital Clinic, Urbana, Illinois. This exhibit consisted of air brush drawings showing typical roentgen aspects of various renal diseases. The purpose was to show the usefulness of air brush drawings in demonstrating roentgenologic pathology. Some of the illustrated cases were from the author's personal collection and others were reproduced from those published in the literature. An effort was made to abolish the unimportant details and to emphasize the characteristic features of each condition.

"The Time Factor in Cerebral Angiography: The Sanchez-Perez Automatic Cranial Seriograph" was the title of an exhibit by J. M. Sanchez-Perez, M.D. (by invitation), University of Southern California School of Medicine, Beverly Hills, California. The exhibit consisted of twenty-eight cerebral angiograms, selected from a series, and the Sanchez-Perez automatic cranial seriograph. Charts were included explaining the time factor in cerebral angiography. The apparatus has a magazine provided for six specially constructed cassettes of 10 by 12 inch size which are run automatically every $2\frac{1}{2}$ seconds with the slow speed and all six in $4\frac{1}{2}$ seconds with the fast speed, there being a synchronization with the timer. Each cassette is numbered from 1 to 6 with a lead number so that the sequence can be established after develop-

ment, and the position of the head can be recognized.

The regularity of the intervals gives in the resulting angiograms, not only the possible anatomical distortion or pathological condition but when the six roentgenograms are considered together they constitute a graphic representation of the physiological function of the circulation in the brain.

Another exhibit was entitled "Pneumarthrography of the Knee: An Aid in Internal Derangements" and was presented by W. H. McGraw, M.D., H. E. Snedden, M.D., J. W. Mulkley, M.D., and M. D. Sachs, M.D. (all by invitation), Crile Veterans Administration Hospital and Western Reserve University Medical School, Cleveland, Ohio. This exhibit, with its evaluation, was primarily designed to aid in the early and accurate diagnosis of the many conditions involving the knee joint. It was offered to illustrate the scope of the diagnostic value of pneumarthrography. The following subjects were included in the exhibit: (1) a short history of pneumarthrography; (2) special transparencies to illustrate the anatomy of the knee joint; (3) the methods of technique were outlined; (4) pneumarthrograms were shown with variations of the normal of internal structures of the knee; (5) illustrative cases were presented in detail; (6) an evaluation of pneumarthrography was included; (7) among the surgical advantages it was pointed out that few if any exploratory operations are necessary on the knee joint.

"Cancer Teaching Models Permitting Palpation" by Leonard B. Goldman, M.D., and Abram Belskie, F.N.S.S. (both by invitation), New York Medical College and Queens General Hospital, New York, New York, was a very interesting exhibit which consisted of life-sized, full-colored models of various parts and organs of the body demonstrating early cancer. These models may be palpated. The following were shown: 1. Mouth models with cancer in various locations. 2. Ear, nose and throat models demonstrating malignant lesions. 3. Breasts showing various tumors; a female bust demonstrating radical mastectomy. 4. Models of lungs. 5. Gynecological models demonstrating types of cancer of the cervix and fundus. 6. Radium insertion: To show radium needles in tongue, radium tandem in the uterus, and colpostat and corks in the vagina.

Lewis E. Etter M.D. (by invitation), Western State Psychiatric Institute and Clinic, Pittsburgh, Pennsylvania, presented an unusual exhibit entitled "New Method for Roentgen Anatomical Study of the Skull." This new method was developed by disarticulating normal skulls and making films of the separate bones and of the skull with and without the bone in question to illustrate clearly the components of each bone as seen on the roentgenogram in the various standard projections. The exhibit of the roentgenograms so made was prepared by cutting out the black background, mounting and labelling the silhouettes on cleared film. The illustrations included the components of the sphenoid, the maxillae, the frontal and ethmoid bone, the petrous pyramid, the sphenoid bone and optic canal showing the optic foramen position, the parietal bones, the occipital and the temporal bones. The roentgenograms of bones of the skull specimens were presented with and without the respective bone in various positions, such as posteroanterior view, lateral view, basal view, oblique view. Waters position, etc., so as to obtain roentgen images for guidance in the proper interpretation of routine roentgenograms and also to have examples for teaching. As a visual aid the method of cutting out the image in the roentgenogram from the black background and glueing this image to a cleared film gives one ample space for lettering the anatomical features directly. Examples of normal skulls with pneumoencephalograms were included to illustrate this point. The final film with the image on is mounted between two sheets of plexiglass. This exhibit was awarded a Certificate of Merit.

An extremely interesting exhibit was presented from the University of Chicago

and Argonne National Laboratory, Chicago Illinois, by James Crosbie, M.D., Burton Grossman, B.S., Charles L. McKeen, B. S., Richard Elghammer, B. S., and J. Garrott Allen, M.D. (all by invitation), entitled "Irradiation Hemorrhage: Heparinemia(?)." This exhibit showed evidence that hemorrhagic aspects of total body irradiation may be due to the release of heparin and that such hemorrhage can be largely controlled by the administration of protamine sulfate or toluidine blue. The role of the heparin like substance in the bleeding tendency can best be determined by measuring the in vitro tolerance of the blood to heparin. The sources of heparin and its extraction from animal tissue and its purification were illustrated stating that heparin has never been synthesized in the laboratory. The reactions of heparin with toluidine blue were demonstrated. Heparin forms metachromatic purple color with toluidine blue. Its anticoagulant effects are neutralized by toluidine blue. The reactions with protamine sulfate were also indicated.

Examples were given showing that dogs exposed to lethal doses (450 r) of roentgen radiation developed progressive leukopenia, anemia and thrombocytopenia with prolongation of clotting and bleeding time leading to hemorrhage. This hemorrhage is well controlled by protamine sulfate or toluidine blue although the life is only slightly prolonged. A decreased heparin tolerance and control of hemorrhage with antiheparin therapy has been noted in (1) acute leukemia; (2) hemophilia; (3) irradiation injury; (4) hemorrhage complicating nitrogen mustard therapy. In idiopathic thrombocytic purpura the heparin tolerance may be normal or decreased. Response to antiheparin therapy is variable and usually incomplete. No response to antiheparin therapy has been observed in hemophilia or the prothrombin deficiencies. The heparin tolerance test serves to determine the ability of protamine sulfate to coagulate heparinized normal blood. The blood tolerance for heparin can be measured by a simple titration procedure. For the therapy one can use protamine sulfate intravenously or intramuscularly as a 1 per cent solution in doses of 0.5 to 3.5 mg. per kg. of body weight two to three times daily or toluidine blue intravenously in doses of 0.5 to 3.5 mg. per kg. body weight in 250 to 500 cc. normal saline once a day or every second day. This exhibit was awarded the Silver Medal, the highest award in this year's Scientific Exhibit.

An interesting exhibit was presented by Lee A. Hadley, M.D. (by invitation), Syracuse, New York, entitled "Intervertebral Foramen Studies." The exhibit consisted of specimens showing normal and abnormal intervertebral foramina mounted in transparent plastic together with the roentgenogram and stained sections from the specimen. The purpose of the exhibit was to show different ways in which the intervertebral foramen may become constricted, limiting the reserve cushion space; and to demonstrate by cadaver material actual compression and distortion of the nerve root by herniation of disc substance backward into the intervertebral foramen.

At the movable intervertebral foramen, there is a generous cushion space about the nerve, the latter being only about one-fifth the diameter of the opening. Restriction of this reserve cushion space results from foramen encroachment, predisposing to nerve root pressure. The foramen is relatively smaller compared to the nerve root than is the lower spinal canal as compared to the cauda equina.

Roentgenograms of patients showed different types of foramen encroachment: (1) physiologic; (2) traumatic; (3) degeneration of intervertebral disc with (a) spur formation backward from the disc margin, (b) spur formation forward from the posterior articulation, (c) pedicles coming closer together, (d) subluxation with telescoping of the posterior articulation forward into the foramen and wedging forward of the underlying body and (e) hyperplasia of the posterior capsule or ligamentum flavum; (4) disc substance bulging backward into the foramen causing nerve

root pressure. In certain cases the nerve root is actually compressed by herniation of disc substance backward into the foramen. Patients operated upon for symptoms of nerve root pressure ("herniated nucleus pulposus," "ruptured disc") must have their intervertebral foramen investigated. It is not sufficient just to explore the spinal canal. Decompression of this vulnerable opening may be necessary.

The exhibit entitled "Medicine at Operation Crossroads" presented by the Navy Department, Bureau of Medicine and Surgery (by invitation), Washington, D.C., was a beautifully worked up exhibit and attracted much attention. The exhibit was divided into three sections. The first section, the Naval Medical Research Section, demonstrated research projects in radiation injuries at Bikini. Numerous photographs illustrated the disposition of the animals and the arrangement of the laboratories on the U.S.S. *Burleson*. The hematologic changes as well as specimens of organs showing the gross pathologic changes in various animals were given and the effects were compared with those following exposure to total body 1,000 kv. roentgen irradiation. The outstanding acute changes were ulceration of the various organs, associated with severe blood changes and anemia and other infections. This section also illustrated the effects on the survivors of the Bikini test. Samples of materials from military clothing were exhibited exposed to atomic bombing on target ships. Two goats, one being Angora goat No. 135, "Satan," and the other an Alpine goat, No. 156, were a part of the exhibit for a short time. These goats were exposed on target ships. Physical examination following the test explosion revealed no frank injury. Laboratory studies indicated subclinical ionizing radiation effects. The later clinical course was characteristic of sublethal ionizing radiation injury. The goats received transfusions (200 to 400 cc.) daily for thirty days following the atomic blast and on alternate days thereafter for thirty days; also penicillin (2,500,000 units) daily for ninety days following the blast. Both goats showed complete recovery and at present are in excellent health.

The second section, which was the Radiological Safety Section, illustrated the preventive measures instituted against radioactive hazards peculiar to the atomic bomb which enabled the Task Force personnel to return safely to the target area as rapidly as possible. Radiation hazards resulting from detonation of the atomic bomb were: (1) external radiation hazards (a) instantaneous—heat, neutrons and gamma radiation; (b) residual—fission products deposited by atomic cloud emit beta and gamma rays; and (2) internal radiation hazards (a) absorbed fission products by lungs and skin abrasions (b) ingested fission products in food and water.

The third section was the Damage Control Safety Section. This included illustrations for the training of safety officers and boarding teams which were specially indoctrinated in safety and damage control incident to the hazardous initial boarding operations. Their mission was successfully completed without injury. The various apparatus and instruments, equipment and type of uniform used were exhibited. Animated illustrations showed the surface explosions and the methods used for entering Bikini.

The "Veterans Administration Radiological Section Information Booth" (by invitation), Washington, D. C., showed various architectural schemes for proposed 500 bed general, medical and surgical hospitals, 1,000 bed surgical hospitals, and 1,000 bed general medical hospitals. Someone connected with the Veterans Administration was always at the booth to give information to those interested.

"Anomalies of the Aortic Arch and Its Branches" was the title of an exhibit by Jesse E. Edwards, M.D. (by invitation), Mayo Clinic, Rochester, Minnesota. The exhibit showed by color drawings the anatomy of and the developmental basis for the anomalies of the aortic arch system which may interfere with the function of

the trachea and the esophagus. In the first two rows were illustrated a group of anomalies of the aortic arch and its branches called Group I. One feature that each member of this group has is that the ductus arteriosus and the descending aorta are in essentially normal positions. The ductus arteriosus is the left-sided structure and the descending aorta lies in the left side of the thorax.

The various configurations of the members of Group I may be considered modifications of the aortic arch anomaly known as functioning double aortic arch. As a result of narrowing, atresia or disappearance of certain segments of the functioning double aortic arch, the configurations shown are obtained.

In the third and fourth rows were shown anomalies of Group II. These are essentially mirror images of respective members of Group I because they are characterized by the presence of a right-sided ductus arteriosus and by the presence of the upper portion of the descending aorta in the right side of the thorax. In the lower part of the thorax, the aorta crosses the midline to emerge from the thorax through the aortic hiatus of the diaphragm.

As in Group I the modified structure is the functioning double aortic arch, from which by narrowing, atresia or disappearance of certain portion of the double arch, the various members of Group II are derived. Group II is by far smaller than Group I. Some of the patterns shown have not as yet been encountered.

An exhibit entitled "Cancer Cells in Sputum and Bronchial Secretions: An Aid in Diagnosis of Bronchogenic Carcinoma" was presented by Lewis B. Woolner, M.D., and John R. McDonald, M.D. (both by invitation), Mayo Clinic, Rochester, Minnesota. This exhibit showed the clinical value of cytologic examination of sputum and bronchial secretions as an aid in diagnosis of bronchogenic carcinoma. It included: (1) the technique of collection of material and the fixation and staining of the smears; (2) the cytology of normal sputum; (3) the demonstration of cancer cells in sputum, and in bronchial secretions originating from the various histopathologic types of carcinoma of the lung; (4) case histories including roentgen findings, results of bronchoscopy, cytologic studies and the findings at surgery or necropsy illustrating the diagnostic value of this method; (5) an analysis of the data on 200 consecutive cases in which the sputum or bronchial secretions were positive for carcinoma cells. Beautiful color photomicrographs, kodachrome photographs, roentgenograms, and color photographs of the gross specimen illustrated each case.

Another exhibit dealing with malignant disease was "The Role of Nitrogen Mustard as an Adjunct to Radiation Therapy of Malignant Diseases; A Clinical Study of 75 Cases" by Bernard Roswit, M.D., and Gustave Kaplan, M.D. (both by invitation), U. S. Veterans Hospital, Bronx, New York. At present there is keen and widespread interest among radiologists and internists alike in the new nitrogen mustard drugs for the therapy of malignant diseases. In this exhibit was presented the authors' experience with HN2 (methyl-bis(beta-chlorethyl)amine hydrochloride) as an adjunct to radiation therapy in 75 cases of Hodgkin's disease, lymphosarcoma, leukemia, bronchogenic carcinoma and a variety of other malignant disorders. The clinical research began in January, 1947, in collaboration with the Committee on Growth of the National Research Council, and included serial studies of bone marrow, peripheral blood, lymph nodes and postmortem material. The authors are convinced from these studies that HN2 is of value only as an adjunct to irradiation, in those cases of Hodgkin's disease, lymphosarcoma and leukemia which are generalized, advanced or radioresistant. HN2 should not be employed in early or radiosensitive cases. In patients with inoperable bronchogenic carcinoma HN2 has been of some value. A large variety of other advanced, inoperable malignant disorders did not benefit from HN2. The important

complications are leukopenia, aplastic anemia and thrombocytopenia. Charts were given showing clinical study, chemistry, indications, contraindications, pharmacodynamics, technique, toxic reactions, clinical material, results and conclusions. In one panel representative clinical cases were illustrated. Roentgenograms, photomicrographs and photographs were shown.

Another exhibit from the Argonne National Laboratory and the University of Chicago, Department of Medicine, Chicago, Illinois, was "The Effect of Induced Anemia on Radiation Damage" by Leon O. Jacobson, M.D., Matthew H. Block, Ph.D., M.D., E. K. Marks, Ph.D., E. O. Gaston, Ph.D., and E. L. Simmons, Ph.D. (all by invitation). It was shown graphically that normal rabbits given a median lethal dose of roentgen radiation (800 r total body), develop an anemia reaching its maximum fourteen days after exposure; whereas, animals that are already anemic by virtue of the phenylhydrazine administration or phlebotomies develop no further anemia after exposure to the median lethal dose of roentgen radiation. Photomicrographic illustrations were presented which demonstrated that this difference in effect is due to the virtually complete destruction of erythrocyte precursors in the normal animal after irradiation, whereas in animals already anemic before irradiation, a sufficient number of erythrocyte precursors survive the irradiation to insure a normal production of erythrocytes.

An interesting exhibit entitled "Deformities of the Bladder Secondary to Ureteral Stone" was presented by Bernard Hall, M.D. (by invitation), Leo G. Rigler, M.D., and Harold O. Peterson, M.D., St. Paul and Minneapolis, Minnesota. Deformity of the bladder as a result of edema and injection of the bladder wall caused by a ureteral stone is a fairly common finding. The ureteral stone must be located in the intramural part of the ureter to produce these changes. The deformity observed on roentgenograms varies from extremely minimal findings to gross changes resembling a primary carcinoma of the bladder. All of these findings have long been recognized by the urologist during cystoscopic examinations, but have too often escaped notice by roentgenologists. They were exhibited by diagrams and roentgenograms and the significance of recognizing the deformity was pointed out.

An exhibit entitled "A Seriograph for Intracranial Angiography" was presented by Solomon Fineman, M.D., Montefiore Hospital, New York, New York. The exhibit consisted of (1) a practical and inexpensive apparatus designed to serve as a combination seriograph, table and stretcher, for intracranial angiography; (2) the construction of the apparatus makes possible lateral and anteroposterior angiography without changing the patient's position on the seriographic table; (3) a simple mechanism for rapid change of cassettes makes it possible to obtain an arteriogram, capillarogram and venogram during a single injection of 10 to 15 cc. of diodrast; (4) arteriograms, capillarograms and venograms obtained with the use of the apparatus as well as the advantage to be gained from three phase angiography in the diagnosis of cerebral tumors were illustrated.

An exhibit on "A Photofluorographic Method for Angiocardiography" was presented by Harold L. Temple, M.D., Israel Steinberg, M.D., and Charles T. Dotter, M.D. (all by invitation), New York Hospital, Cornell Medical Center, New York, New York. Angiocardiography as described in 1938 by Robb and Steinberg was carried out employing a photofluorographic camera designed to shift automatically 70 mm. film strips, rapidly exposing successive frames. This equipment which makes use of the relay system and a Fairchild camera was constructed by the General Electric Company. Illustration of the method and results comprised this exhibit. The 70 mm. films can be read with almost as accurate results as the 14 by 17 inch standard films.

Another exhibit dealing with the heart

was "The Integrated Examination of the Congenital Cardiac" by the Cardiovascular Research Group (by invitation), The Mount Sinai Hospital, New York, New York. The exhibit included case histories of congenital cardiacs to show how an integrated examination permits of accurate anatomical and physiological diagnosis. The data illustrated the detailed case history, clinical examination, angiocardiogram, electrocardiogram, phonocardiogram, result of intracardiac catheterization, arterial and venous pulse tracings, electrokymogram and finger plethysmogram.

"The Early Detection of Gastrointestinal Lesions by Photofluorography" was the title of an exhibit by John F. Roach, M.D. (by invitation), Robert D. Sloan, M.D. (by invitation), and Russell H. Morgan, M.D., Department of Radiology, Johns Hopkins Hospital, Baltimore, Maryland. The exhibit illustrated the experimental findings of a study currently in progress at the Johns Hopkins Hospital to explore the application of mass roentgenographic methods to the early diagnosis of gastric cancer.

Another interesting exhibit on the intestinal tract was entitled "A Rapid Method of Roentgenologic Examination of the Small Intestine" by Sydney Weintraub, M.D., and Robert G. Williams, M.D. (both by invitation), New York Hospital, Cornell Medical College, New York, New York. The exhibit consisted of transparent copies of roentgenograms demonstrating the appearance of the small intestine in normal and pathological cases with use of the rapid method. The technique was explained on a panel, and a brief summary of results obtained with this method in normal and pathological cases filled a second panel. The remainder of the panels showed illustrative normal and pathological cases, including cases of regional enteritis, "deficiency pattern," sprue and small intestinal tumors. The method, briefly, is as follows: A barium-normal saline mixture is used as the contrast medium followed by 8 ounces of ice cold normal saline immediately and a second 8 ounces of ice cold normal saline five minutes after initial roentgenoscopic and film examination of the upper gastrointestinal tract. Abdominal roentgenograms are taken at five, fifteen and thirty minutes after the drinking of the first 8 ounces of ice cold normal saline. Roentgenograms are shown "wet" to the roentgenologist who will roentgenoscope and take spot films of suspicious areas. If the head of the meal has not yet reached the cecum, further films are taken at one-half or one hour intervals until it has.

"Tumors of the Kidney" was a beautifully prepared exhibit presented by Robert A. MacArthur, M.D., D.Sc., and H. C. Tellman, M.D. (both by invitation), Harper Hospital, Detroit, Michigan. The title was used in the broad sense of the word as cysts and polycystic kidney disease were also considered. The exhibit consisted of about 200 transparencies of roentgenograms, pyelograms and photographs of gross specimens, many of which were colored. The series included 16 cases of polycystic kidneys, 12 cases of solitary cysts, 1 case of hemorrhagic cyst, 10 cases of pelvic neoplasms, 1 case of pelvic hemangioma, 16 cases of parenchymal neoplasms in adults and 6 cases of Wilms' tumor. In discussing the differential diagnosis another 25 cases were presented because their pyelograms simulated renal tumors. In this series there were cases of pyonephrosis, solitary renal abscess, hydronephrosis, carbuncle of the kidney, renal tuberculosis, multiple cysts of the kidney, double kidney with pyonephrosis of the upper kidney, actinomycosis of the kidney, non-opaque calculus of the renal pelvis, massive renal infarction, intracapsular rupture of the kidney, extracapsular rupture of the kidney, calcified pyonephrosis, calcified spleen, splenomegalia, carcinoma of the pancreas, carcinoma of the adrenal gland, extrarenal angiosarcoma with teratoid growth distorting pyelographic pattern, abdominal aneurism, and Hodgkin's disease of the peri-ureteral glands. Finally a group of 4 rare lesions was displayed.

These were: (1) actinomycosis of the kidney; (2) large solitary cyst of the kidney in an infant four and a half months of age; (3) a case of Wilms' tumor living and well four and a half years following nephrectomy and postoperative irradiation, and (4) a case with 4 primary tumors, including a bladder tumor and a tumor of the renal pelvis. This exhibit represented an unusual wealth of clinical material and was awarded a Certificate of Merit.

"Hemosiderosis of the Lung Due to Mitral Heart Disease" was the title of an exhibit by Eugene P. Pendergrass, M.D., Edwin L. Lame, M.D. (by invitation), and Herman W. Ostrum, M.D. (by invitation), Hospital of the University of Pennsylvania, the Philadelphia General Hospital and the Presbyterian Hospital, Philadelphia, Pennsylvania. This exhibit dealt with mitral valve disease accompanied by the deposition of hemosiderin in the lungs in such fashion that roentgenograms reveal a fine nodulation much like pneumoconiosis or miliary tuberculosis. The condition is very rare. Three samples of exogenous siderosis are: arc-welding, inhaling of iron ladened fumes by silver finishers working in rouge (iron oxide) and grinding of ferrous metal. Endogenous pulmonary siderosis is exemplified by the presented cases of mitral heart disease and by the children who suffer severe anemias and die with hemosiderin nodules in the lungs. Reproductions were shown of roentgenograms of the lungs on 4 autopsied and 2 living cases of pulmonary hemosiderosis secondary to rheumatic mitral valve disease. Microscopic study on the 4 autopsied cases showed that collections of hemosiderin caused the discrete nodular pulmonary lesions seen in the roentgenograms. Such cases are of interest especially in differentiation from pneumoconiosis, miliary tuberculosis and a host of other nodular discrete pulmonary lesions. The excellence of this exhibit won the Bronze Medal, the second highest award given in the Scientific Exhibit.

Orrin S. Cook, M.D., and Wallace M. Roy, M.D., Sacramento, California, presented an exhibit entitled "Body Section Roentgenography of the Facial Bones and Cervical Spine." The value of body section roentgenography in demonstrating anomalies, fractures and other lesions involving the facial bones and cervical spine was shown. Its routine use for roentgenography of the odontoid process of the atlas was suggested.

An exhibit which came in too late for inclusion in the program was entitled "A Non-typical Collection of Free Exudative Fluid in the Diaphragmatic Part of the Pleural Cavity" by Apostalos Yiannacopoulos, M.D., University of Athens, Athens, Greece. The exhibit included three cases illustrating an uplift of the diaphragmatic dome which in fact constitutes a false uplift (pseudo-anosis) due to the collection of free fluid in the diaphragmatic part of the pleural cavity. In these cases it is believed that the pressure on the bronchial tree which leads to the pulmonary base by infiltrated glands results in an imperfect expansion of the corresponding part of the lung. Thus an increased negative pressure is produced in the diaphragmatic part of the pleural cavity and the free exudative fluid is collected there preferably.

An interesting exhibit from the Children's City Hospital, Havana, Cuba, by Agustin Castellano, M.D., and Raul Pereiras, M.D. (both by invitation), was entitled "Angiocardiography, Anatomo-roentgenologic Form of the Transposition of the Large Vessels." The demonstration of the cardiac silhouette is of no value in the diagnosis of the different varieties of transposition of the large vessels. This exhibit illustrated that angiocardiography permits it to be known from which cavity emerge the large vessels as well as their direction and diameter. On the basis of this it is possible to diagnose four anatomo-roentgenologic types of angiocardiograms which are of practical importance. These four types were illustrated with diagrams, standard roentgenograms and angiocardiograms taken in various views.

"Portable Roentgen Film Projector"

was the title of an exhibit by Raymond A. Dillon, M.D., and William P. Murphy, Jr., M.D. (both by invitation), Boston, Massachusetts. An optical apparatus designed and constructed by the exhibitors for the projection of original roentgenograms onto a large screen before a large or small audience was demonstrated. Wall charts showed the theory of operation and the construction detail. This exhibit was awarded a Certificate of Merit.

From the Isotopes Division, Atomic Energy Commission, Oak Ridge, Tennessee, was an exhibit prepared by Paul C. Aebersold, Ph.D., W. G. Morgan, M.D., and Bernard G. Saunders (all by invitation) and entitled "Isotopes for Radiology." The procedure for obtaining radioisotopes for therapy and medical research was presented in visual form. Charts and diagrams portrayed several therapeutic applications of radioisotopes. The health physics aspects of radioisotopes usage was illustrated by photographs of monitoring procedures and hood and laboratory design. Typical instruments used in health physics instrumentation completed the exhibit.

TECHNICAL EXHIBIT

In the previous pages of this issue are given accounts of the various activities connected with the Forty-ninth Annual Meeting of the American Roentgen Ray Society held in Chicago, September 14 to 17, 1948. The merits of the scientific sessions and the papers have been discussed and a description given of the Scientific Exhibits. However no report of this meeting would be complete without adequate mention of the Technical Exhibit. Each year has seen a continued increase in the number of technical exhibitors and in the size of the total exhibit. Along with this physical increase in size has gone an added attractiveness of display of the exhibits as well as an advance in engineering designs. The exhibit this year outdistanced all previous exhibits in all of these phases. As to the mere size of the exhibit a comparison with 1947 is interesting: In 1947, twenty-nine manufacturers reserved a total of sixty-one booths and 236 technical exhibitors were registered at the meeting; in 1948, thirty-six manufacturers reserved a total of seventy booths and 378 technical exhibitors were registered. As to the remaining features of the exhibit, each manufacturer had put forth great effort to make his display an outstanding one and there were many new types of apparatus shown and many new designs of equipment. The resulting exhibit, therefore, was one which was both attractive and functional. That the radiologists were aware and appreciative of this was evidenced by the fact that the exhibits were unusually well attended, not only, as would be expected, during the periods set aside in the scientific program for their viewing but also at all other hours of the day. The Society wishes to extend its thanks to the Technical Exhibitors for their large share in making the Forty-ninth Annual Meeting the success it was.

The following firms were represented in the Technical Exhibit: *Ansco*, Binghamton, N. Y.; *George W. Borg Corporation, Gibbs Division*, Delavan, Wis.; *Buck X-Ograph Company*, St. Louis, Mo.; *Canadian Radium and Uranium Corporation*, New York, N. Y.; *E. I. duPont de Nemours and Company*, Wilmington, Del.; *Eastman Kodak Company*, Rochester, N. Y.; *Eldorado Mining and Refining, Ltd.*, Ottawa, Ontario; *El-Tronics, Inc.*, Philadelphia, Pa.; *Eureka X-Ray Tube Corporation*, Chicago, Ill.; *Fairchild Camera and Instrument Corporation*, Jamaica, N. Y.; *General Electric X-Ray Corporation*, Milwaukee, Wis.; *Paul B. Hoeber*, New York, N. Y.; *Kelley-Koett Manufacturing Co.*, Covington, Kentucky; *Lea & Febiger*, Philadelphia, Pa.; *Liberty Dressing Company*, Gloversville, N. Y.; *Liebel-Flarsheim Company*, Cincinnati, Ohio; *Machlett Laboratories*, Springdale, Conn.; *F. Mattern Manufacturing Company*, Chicago, Ill.; *Medical Bureau*, Chicago, Ill.; *Wm. Meyer Company*, Chicago, Ill.; *Micro-equipment Corporation*, Chicago,

Ill.; *North American Philips Company*, New York, N. Y.; *Picker X-Ray Corporation*, New York, N. Y.; *Poole and Parker, Inc.*, Tulsa, Okla.; *Radium Chemical Company*, New York, N. Y.; *Schering Corporation*, Bloomfield, N. J.; *Frank Scholz X-Ray Engineering Service*, Boston, Mass.; *Standard X-Ray Company*, Chicago, Ill., *Charles C Thomas, Publisher*, Springfield, Ill.; *Universal X-Ray Products*, Chicago, Ill.; *Victoreen Instrument Com-Company*, Cleveland, Ohio; *Westinghouse Electric Corporation*, Pittsburgh, Pa.; *Winthrop-Stearns*, New York, N. Y.; *Wright Engineering Company*, Mountain Lakes, N. J.; *Year Book Publishers*, Chicago, Ill.

NEW OFFICERS

At the Forty-ninth Annual Meeting of the American Roentgen Ray Society held at the Palmer House, Chicago, Illinois, September 14–17, 1948, the following officers were elected for the year 1948–1949: *President-Elect:* U. V. Portmann, Cleveland, Ohio; *1st Vice-President:* Charles M. Richards, San Jose, California; *2nd Vice-President:* Earl E. Barth, Chicago, Illinois; *Secretary:* H. Dabney Kerr, Iowa City, Iowa (re-elected); *Treasurer:* Wendell G. Scott, St. Louis, Missouri (re-elected); *Member of the Executive Council:* Paul A. Bishop, Philadelphia, Pennsylvania; *Historian:* Ramsay Spillman, New York, New York (re-elected). The *President* is Lawrence Reynolds, Detroit, Michigan, and the *Chairman of the Executive Council* is Hugh F. Hare, Boston, Massachusetts.

FIFTIETH ANNUAL MEETING

It was announced in the July, 1948, issue of the JOURNAL that the Fiftieth Annual Meeting of the American Roentgen Ray Society would be held in San Francisco, California, September 6–9, 1949. At the recent meeting of the Society in Chicago it was decided that for a number of reasons the meeting place should be changed. The Society has been released from its reservation in San Francisco and the Fiftieth Annual Meeting of the American Roentgen Ray Society will be held at the Netherland Plaza Hotel, Cincinnati, Ohio, October 4, 5, 6 and 7, 1949.

THE THIRD INTER-AMERICAN CONGRESS OF RADIOLOGY

The Third Inter-American Congress of Radiology will assemble in Santiago, Chile, Friday, November 11, 1949, to Thursday, November 17, 1949, both dates included.

The Chilean Radiological Society has appointed as President, Dr. Felix J. Daza; as General Secretary for Latin-America, Dr. Santiago H. Calderón; as General Secretary for the United States and Canada, Dr. César A. Velasco; as General Treasurer, Dr. Alberto H. Ricci.

Participants in the Third Inter-American Congress of Radiology will be classified as follows: *Honorary members*—those appointed by the Chilean Radiological Society; *Titular members*—those radiologists who apply and are accredited by their respective societies; *Associate members*—those physicians who are not specialists in radiology, technicians, experts, manufacturers of electromedical equipment, and others who may apply, the latter being limited to three for each titular member.

James T. Case, M.D., 55 East Washington Street, Chicago 2, Illinois, has been delegated as regional secretary for the United States.

The Committee on International Affairs of the American College of Radiology, consisting of Ross Golden, M.D., Hugh F. Hare, M.D., Maurice Lenz, M.D., Charles L. Martin, M.D., Frazier J. Payton, M.D., Juan A. del Regato, M.D., M. C. Sosman, M.D., Calvin L. Stewart, M.D., and James T. Case, M.D., has been designated by the American College of Radiology, the American Radium Society, the American Roentgen Ray Society, and the Radiological Society of North America as their official committee of arrangements.

Application for membership in the Congress should be made at the earliest possi-

ble date, so that the Chilean Organizing Committee may have an adequate estimate of the extent of the preparations they need to make. The membership fee of twenty dollars should accompany the application.

The official languages will be Spanish, Portuguese, English and French. We are informed that provision will be made whereby earphones will be available for all who desire them, so that addresses given in Spanish may be heard simultaneously in English, or vice versa. This means, of course, that those members wishing to offer English contributions to this Congress, will arrange to have them translated into Spanish here or else get them into the hands of the regional secretary to be forwarded to the Congress headquarters in Santiago, Chile, sufficiently in advance of the meeting to permit time for translation.

The official subjects for consideration at the Congress will be the following:

A. "Radiological Exploration of the Cardiovascular System with Opaque Material."
B. "Diagnosis and Simple Radiological Exploration of the Skull," which has been subdivided into
 1—a) "Skull in General."
 b) "Sella Turcica."
 2—c) "Orbits."
 d) "Paranasal Cavities."
 3—e) "Temporal Bone."
C. "Radiation Treatment of Cancer of the Tongue."
D. "Radiation Treatment of Cancer of the Cervix."

The last two subjects will consist essentially of the following:

(1) Technique of radiotherapy.
(2) Immediate and subsequent reactions.
(3) Case reports illustrating degree and histological type of cancer.

The official speakers will be named by the Executive Committee after duly considering the recommendations from the committee of each country. The official speaker may present one or more co-lecturers.

Prospective members from the United States who wish to participate in any of the discussions outlined above should communicate with Dr. Case at the earliest convenience, so that the American committee will be able to adjust the discussions to the program by conference with the Program Committee in Santiago.

In addition to these official presentations, there will be time set apart for free subjects not related to the official themes. These may be presented only in the scientific exhibits in order to give them more objectivity. The free subjects will be presented as exhibits with comments.

The Inter-American College of Radiology was organized at the close of the Second Inter-American Congress of Radiology in Havana, Cuba, November, 1946. A convocation of this College will be held in connection with the Congress. Information concerning this College and applications blanks for Fellowship in the College may be obtained from Dr. Case. However, membership in the Third Inter-American Congress of Radiology is independent and not contingent upon fellowship in the College.

The more than three hundred Americans who made up the attendance from the United States at the Second Inter-American Congress of Radiology in Havana, have very pleasant memories of the meeting and many of them will wish to go to the meeting in Santiago in 1949.

The month of November is probably the most favorable time of the year from the standpoint of the weather. It should be borne in mind that the seasons are reversed, our winter being the summer of our South American friends. Excursions are contemplated to the southern part of Chile, especially the lake region, which is very beautiful and which offers opportunities for fishing and skiing, even in the summer months (corresponding to our winters here in the United States).

There is talk of arranging parties for air and sea travel, including a tour of some of the chief cities of South America. Travel-

ling by air, a very reasonable tour of the principal cities of South America and attendance on the full period of the Congress could be accomplished in about twenty days. Our Latin-American colleagues will give generously of their time in facilitating visits to the principal radiological institutions of each large city visited in the course of such a tour.

Further notices will be published from time to time. If any are anticipating, even faintly, possible attendance at this meeting, it is requested they communicate with Dr. Case as soon as possible. Every endeavor will be made to supply information.

Address all communications to the Chairman of the Committee, Dr. James T. Case, 55 East Washington Street, Chicago 2, Illinois.

COURSES IN RADIOISOTOPES

The Oak Ridge Institute of Nuclear Studies announces that four additional radioisotope courses have been scheduled for the fall and winter months. The additional courses are being offered in view of the fact that more than 300 qualified individuals applied for entrance to one of the three courses held during the summer months. There were only 96 places in these three courses.

Dates for the new courses and the fields of interest which will have priority follow:

October 25, 1948.....Industrial personnel
January 3, 1949.....Government personnel
February 14, 1949.....Medical personnel
March 14, 1949.....General

The Committee on Applications, which is comprised of representatives of the Oak Ridge Institute, and the Isotopes Division and the Division of Biology and Medicine of the Atomic Energy Commission, is now accepting applications for the courses. Additional information and application blanks may be obtained from Dr. Ralph T. Overman, Head, Special Training Division, Oak Ridge Institute of Nuclear Studies, P. O. Box 117, Oak Ridge, Tennessee. Individuals interested in attending one of the courses should apply as soon as possible.

Thirty-two participants will be accepted in each of the courses. Each four-weeks course will be divided into laboratory work, lecturers on laboratory experiments, general background lectures, and special-topic seminars. In order to give participants a maximum of knowledge and ability in the handling of radioactive isotopes in research work, experiments will be conducted covering the use and calibration of instruments, and the purification and separation of radioactive materials from inert materials and from other radioactive materials. Other lectures and experiments will illustrate the application of radioisotope techniques.

Mondays, Wednesdays, and Fridays will be devoted to laboratory work, while Tuesdays and Thursdays will be reserved for lectures. Ample time will be allowed for library work and consultation with instructors concerning individual problems. Participants are requested to bring plans of their laboratories, including lay-out, equipment, dimensions and similar information. The radioisotope staff will be available for consultation in connection with efficient organization of the laboratory for radioisotope work.

The courses include several seminars to be conducted by specialists in the various fields of interest. Typical seminars are:

Use of Radioisotopes in Animal Experimentation
Use of Radioisotopes in Plant Experimentation
Use of Radioisotopes in Humans
Principles and Practices of Health-Physics in Radioisotope Work
Design of Radiochemical Laboratories
Dosimetry
Instrumentation for Radioisotope Work
Scope of the Use of Radioisotope Techniques

The courses will be held in the laboratories and classrooms of the Oak Ridge Institute Building in Oak Ridge. No classified material is handled in the course, and

security clearance is not required. The Institute will arrange for passes to admit participants to the Oak Ridge Area. At present, participation is limited to citizens of the United States.

A registration fee of $25.00 is charged each participant. Laboratory coats, gloves and equipment will be furnished.

Participants will be housed in dormitories at a reasonable cost.

UROLOGY AWARD

The American Urological Association offers an annual award of $1,000.00 (first prize of $500.00, second prize $300,00 and third prize $200.00) for essays on the result of some clinical or laboratory research in urology. Competition shall be limited to urologists who have been in such specific practice for not more than five years and to residents in urology in recognized hospitals.

The first prize essay will appear on the program of the forthcoming meeting of the American Urological Association, to be held at the Biltmore Hotel in Los Angeles, May 16–19, 1949.

For full particulars write the Secretary, Dr. Thomas D. Moore, 899 Madison Avenue, Memphis 3, Tennessee. Essays must be in his hands before February 15, 1949.

Committee on Scientific Research
Miley B. Wesson, *Chairman*
Anson L. Clark
John E. Heslin

MEDICAL SYMPOSIUM ON THE CANCER PROBLEM

The American Cancer Society will hold a Medical Symposium on the Cancer Problem at the Hotel Commodore, New York, New York, on November 6 and 7, 1948. The following program will be given:

The Cancer Problem Today:
- Cancer—A World Problem. Charles S. Cameron, M.D.
- Cancer—A National Problem. John R. Heller, Jr., M.D.
- Cancer—A Personal Problem. 1. Are There Dangers in Lay Cancer Propaganda? Daniel A. Blain, M.D., 2. Creating Awareness. Herbert L. Lombard, M.D.

The Problem of Treatment—Recent Advances:
- Diagnosis of Breast Tumors by Radioactive Phosphorus. B. V. A. Low-Beer, M.D.
- Treatment of Diseases of the Hematopoietic System with Artificial Radioactivity. John H. Lawrence, M.D.
- Application of Radioactive Materials in the Management of Thyroid Cancer. Rulon W. Rawson, M.D.
- Castration as a Therapeutic Agent in Cancer of the Male Breast. Norman L. Treves, M.D.
- Hormone Therapy in Cancer of the Female Breast. Ira T. Nathanson, M.D.
- Control of Cancer of the Prostate. Wallace W. Scott, M.D.

Dinner. Speakers: 1. Present Potentials of Radiation Therapy. L. Henry Garland, M.D. 2. What Can We Expect from Atomic Energy? Shields Warren, M.D.

The Lung Cancer Problem:
- Results of Community-Wide Chest X-Ray Programs in Cancer Case Finding. Theodore F. Hilbish, M.D.
- Cytologic Diagnosis of Cancer of the Lung. John R. McDonald, M.D., and Peter A. Herbut, M.D.
- Prospects of Improved Control of Lung Cancer. Alton Ochsner, M.D.

Cancer Research, Cancer Education, and the Cancer Problem in General Medical Practice:
- The Progress in Cancer Research at the National Cancer Institute. Harry Eagle, M.D.
- Present Status and Future Plans of Cancer Education in our Medical Schools. Samuel C. Harvey, M.D.
- The Cancer Problems of a Family Doctor. Maurice T. Root, M.D.

ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

Department Editor: George M. Wyatt, M.D., 1835 Eye St., N.W., Washington 6, D. C.

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ROENTGEN DIAGNOSIS

NECK AND CHEST

New, Gordon B., Figi, Frederick A., Havens, Fred Z., and Erich, John B. Carcinoma of the larynx; methods and results of treatment. *Surg., Gynec. & Obst.*, Nov., 1947, *85*, 623–629.

The authors express the conviction that carcinoma of the larynx is a curable disease, particularly when diagnosed accurately and early. However, they feel that no one form of therapy is superior to all others in the treatment of this disease. On the contrary, the type of growth in question, its activity, extent, and location and the age and general physical condition of the patient should be the factors which determine what type of treatment should be instituted in each individual case. In general, low grade laryngeal carcinomas should be treated by surgical measures while extensive high grade, radiosensitive tumors require irradiation. Successful surgical therapy for carcinoma of the larynx is not a question of operative technique alone but of the co-ordinated and collective efforts of the surgeon, pathologist, anesthetist, assistants, and nurses.—*Mary Frances Vastine, M.D.*

Schoolman, Joseph G. Mortality in cancer of the larynx. *Ann. Otol., Rhin. & Laryng.*, March, 1948, *57*, 197–200.

The author reviews the experience in laryngeal cancer in the Department of Otolaryngology at the University of Illinois from 1930 to 1946. During this period, 161 cases were diagnosed as cancer of the larynx. Of these, only 40 were considered operable. Total laryngectomy were performed on 20 patients and laryngofissures on 12 patients.

On the basis of statistical analysis, the author expects 82 per cent of the 12 patients having laryngofissure operations to be cured. Again, on the basis of statistical analysis, he expects 55 per cent of the 28 patients having laryngectomies to be cured. When the entire group of 161 patients were judged statistically, only 15.6 per cent of the patients with cancer of the larynx were living and well at the end of five years.

The author examines the histories of the large incurable group of patients in order to determine whether inoperability was due to tumor activity, patient neglect or physician neglect. He decided that in 45 per cent of the cases, patient procrastination was responsible for the inoperability and in 25 per cent of the cases,

medical mismanagement was responsible for the delay. In reviewing the laryngeal biopsies performed, it was noted that malignancies constituted almost 56 per cent of the total laryngeal biopsies. The diagnoses in the remaining 44 per cent included benign conditions such as papilloma, leukoplakia, polyps, etc.

Though but four pages in length, this article contains a wealth of valuable statistical information.—*Philip J. Hodes, M.D.*

Chatton, P., and Maleki, A. Anatomie radiologique du poumon. (Roentgen anatomy of the lung.) *J. de radiol. et d'électrol.*, No. 7–8, 1947, *28*, 285–310.

This splendid monograph on the roentgenological anatomy of the lung was one of the special reports presented at the Fifth Congress of French Speaking Radiologists held in Paris, October 7–11, 1947, under the presidency of Dr. R. Ledoux-Lebard, Electro-Radiologiste Honoraire des Hôpitaux. These twenty-five pages form a beautiful monograph covering (1) the bronchial tree and bronchial vessels, (2) bronchography, (3) tomography and its contribution to the study of the normal roentgen anatomy of the vessels and bronchi of the lung, (4) the pulmonary segments, fissures and lobes. The article is excellently illustrated with roentgenograms plus anatomic drawings, which are very numerous and most helpful from a reference standpoint in the section dealing with the bronchopulmonary segments. The anatomy of segmental lesions is very thoroughly presented.—*William M. Loehr, M.D.*

Taquino, George J., and Joseph, Gerald F. Carcinoma of the esophagus; an analysis of 145 cases with special reference to metastases and extensions. *Ann. Otol., Rhin. & Laryng.*, Dec., 1947, *56*, 1041–1058.

The authors report a series of 145 cases of carcinoma of the esophagus, 124 of which were proved by postmortem examination.

The duration of symptoms ranged from less than a month to eighteen months. The average duration was less than $5\frac{1}{2}$ months.

Dysphagia was almost always the first symptom which brought the patient to his physician. On careful questioning, however, a considerable number of patients recalled that substernal pain and burning after meals had preceded their dysphagia. An even larger group of patients were able to remember that cough had preceded their dysphagia. The authors believe that cough may be an important early symptom in carcinoma of the esophagus which they attribute to diaphragmatic irritation. Indeed, the authors suggest the advisability of esophagography in all patients with a cough whose lungs seem negative. The authors stress the fact that esophagoscopy is not a trivial procedure and when the examination is planned, it should be a complete examination including biopsy if necessary. The evidence clearly indicates that esophagoscopy with biopsy is indicated in every patient who complains of some abnormality on swallowing or of any other abnormal sensation related to the ingestion of food.

Of considerable interest was the fact that in 4 instances, the diagnosis of carcinoma of the esophagus was completely overlooked until autopsy. In the first patient a laparotomy was performed and a diagnosis of primary intra-abdominal cancer was made. The second patient died of cerebral metastasis from carcinoma of the esophagus. The third patient had a lung abscess and autopsy revealed a suppurative process following central necrosis in a metastatic lung tumor. The fourth patient was thought to have a thoracic aneurysm. He had complained of hoarseness for six months and finally died of a hemorrhage. Autopsy revealed the hoarseness to be due to carcinoma of the esophagus and the hemorrhage was the result of extension of the disease into the aorta.

One of the chief reasons why carcinoma of the esophagus is such a highly fatal disease is that its anatomic location in the midst of important and vital structures makes the esophagus a particularly dangerous site for a malignant process. It has no outer serosal covering and it is richly supplied with lymphatics in the submucosal and muscular coats. Because of this, the growth tends to spread longitudinally, to erode through the esophageal walls with mediastinitis, and to metastasize to the regional lymphatics.

Cachexia and inanition were the most common causes of death. The authors believe that unless gastrostomy is performed early while the patient is in relatively good condition, there is little point to performing it at all. They believe it merely prolongs for a short time a life that is not worth the living.

Of the 145 patients with carcinoma of the esophagus, 2 patients who had radical operations were alive when last seen at the end of one year. Six patients in whom radiation therapy had been used were kept alive from nine to eighteen months.

This article contains many very valuable charts obtaining to the various types of metastases from carcinoma of the esophagus. This is an excellent statistical survey.—*Philip J. Hodes, M.D.*

Putney, F. Johnson. Thoracic stomach produced by esophageal hiatus hernia and congenital short esophagus. *Ann. Int. Med.*, June, 1948, *28*, 1094–1105.

Thoracic stomach results from herniation through a normal or abnormal diaphragmatic opening, or failure of development of the esophagus. The diaphragm has only one normal opening through which gastric hernia is apt to occur and that is the esophageal passageway, considered to be the weakest point in the diaphragm.

The condition is divided into traumatic and non-traumatic types and the subdivisions of each are briefly sketched. In most instances of thoracic stomach, the organ gains access to the thoracic cage through the esophageal opening in the diaphragm. The abnormal position may be produced by congenital short esophagus or by one of the two types of acquired hernia through the esophageal hiatus, namely hiatal hernia and paraesophageal hernia. In herniation through the esophageal hiatus the distinction between paraesophageal and true hiatus hernia is that in the former the lower end of the esophagus remains fixed in its normal position and a portion of the stomach herniates through the hiatal ring adjacent to the esophagus, while in the latter type there is protrusion of both the lower end of the esophagus and a portion of the stomach into the thorax. The length of the esophagus affords the main difference between thoracic stomach produced by a short esophagus and herniation through the esophageal hiatus.

Symptomatology is variable and may simulate either singly or in combination those of gastrointestinal, cardiac, respiratory or gallbladder disease. The most persistent and frequent symptom is difficulty in swallowing but occasionally absence of all symptoms may occur. Roentgen examination usually shows this condition most clearly with the patient in the right oblique prone position, when the contrast mixture can be kept in the cardia by gravity. The hiatus appears above the position that the lower end of the esophagus would normally occupy. The "pinchcock" appearance of the hiatus is absent but the esophageal gastric junction can usually be distinguished even though as often occurs in cases of cardioesophageal relaxation it appears as only a slight indentation in the barium column. Simple relaxation of the lower end of the esophagus probably results from weakening of the fibers about the hiatus. Every case in which relaxation is found should be considered a potential case of hiatal hernia.—*Eugene J. McDonald, M.D.*

Paul, R. N. A new anomaly of the aorta. Left aortic arch with right descending aorta. *J. Pediat.*, Jan., 1948, *32*, 19–29.

The author proposes the following classification of aortic arch anomalies:

A. Right aortic arch.
 1. Right aortic arch with right ascending aorta
 2. Right aortic arch with retroesophageal aorta
 a. Left descending aorta
 b. Right descending aorta
B. Double aortic arch
 1. Right arch serving as main channel
 2. Left arch serving as main channel
C. Anomalous subclavian artery
 1. Arising from aortic arch or descending aorta
 2. Arising from a right or left aortic arch
D. Coarctation of the aorta
E. Complete interruption of the isthmus of the aorta
F. Left aortic arch with right descending aorta.

Right aortic arch is to be distinguished from dextroposition of the aorta where the aortic opening overrides the right ventricle and from transposition in which the aorta arises entirely from the right ventricle. In right aortic arch with right descending aorta the fourth right arch persists instead of the fourth left arch. The aorta arises from the left ventricle but passes to the right of the esophagus and trachea, over the right main bronchus and descends on the right side. In 25 per cent of a group of 500 cyanotic children studied by the author a right aortic arch with right-sided aorta was present.

In right aortic arch with retroesophgeal aorta, the aorta arises from the left ventricle, passes to the right of the esophagus and trachea but then turns sharply to the left behind the esophagus, and descends to the left of the spine. In most cases the patients are asymptomatic. The heart is usually otherwise normal. The retroesophageal aorta produces characteristic roentgen changes. Confusion may arise where a double aortic arch is present.

In double aortic arch the right and left aortic arches persist. The right aortic arch is usually

the main vessel and the left arch is represented by a partially or completely obliterated tube. The right arch crosses behind the esophagus as in right aortic arch with retroesophageal aorta. The left arch crosses over the trachea and joins the right arch posteriorly and to the left of the esophagus. The differentiation from right aortic arch with retroesophageal aorta depends upon visualization of the left arch coursing over the trachea in the oblique view. Bilateral indentation of the barium-filled esophagus has been demonstrated. Instillation of lipiodol into the trachea may also demonstrate deformity.

The commonest form of anomaly of the subclavian artery is the one arising from the descending aorta and passing in front of the trachea, between it and the esophagus or behind the esophagus. The latter is the most common and displaces the esophagus anteriorly.

Finally the author discusses a new anomaly, discusses 2 case reports and describes the roentgen appearance. In this condition there is a left aortic arch with a right descending aorta. In the anteroposterior view the barium-filled esophagus is indented on the left side by the aortic arch. However, between the aortic knob and the upper left border of the heart there is an absence of cardiac or vascular shadows to the left of the barium-filled esophagus and the esophagus descends far to the left of the midline. Anterior displacement of the esophagus is also present and demonstrable indicating the retroesophageal course of the aorta. These findings when taken together all indicate the presence of a left-sided aortic arch crossing to the right and descending to the right. In the 2 cases presented a findings were confirmed at operation.—*Rolfe M. Harvey, M.D.*

Vivas-Salas, E. Cardiac aneurysm in a child of seven years of age. *Am. J. Dis. Child.*, Jan., 1948, *75*, 92–99.

A case of ventricular aneurysm in a boy, aged seven, is reported. The electrocardiographic observations similar to those seen in lesions of the wall of the heart pointed to severe myocardial damage.

Three types of aneurysm due to congenital defects of the heart have been described. The first type was described by Abbott as "diverticulum of the heart." This type is of little importance except as a rare pathologic specimen. The second type is thought to be due to an anomaly in the development of the muscle bundles. Only one such case has been described in the literature. The third type that may give rise to cardiac aneurysm is the anomalous origin of the left coronary artery from the pulmonary artery.

The fluoroscopic examination of the heart showed normal diaphragmatic movements. The hilar shadows were somewhat accentuated. The vascular pedicle was normal. The cardiac shadow in the anteroposterior view was increased in size, and an irregular bulge was noticed along the lowermost arc, left border. This bulge was of less density than the rest of the cardiac shadow, had a somewhat ledgelike superior border and showed decided paradoxic pulsations. It expanded in systole when the rest of the heart contracted. This paradoxic pulsation was so pronounced that under the fluoroscopic screen the aneurysmal bulge seemed always to be on the point of bursting. It was impossible to disengage the aneurysmal bulge from the rest of the cardiac shadow with rotation of the patient into various oblique positions.

The author believes that the patient had a cardiac aneurysm, based on roentgenologic evidence and the fact that the electrocardiogram showed evidence of severe myocardial disease. The only possible cause, he believes, was a congenital defect due to either a developmental defect of the muscle bundles of the ventricle or to inadequate nourishment of the ventricular wall caused by the anomalous origin of the left coronary artery from the pulmonary artery. He states that congenital cardiac aneurysm is not necessarily fatal in the first year of life.—*R. S. Bromer, M.D.*

Dickson, Roger W., and Jones, John P. Congenital heart block in an infant with associated multiple congenital cardiac malformations. *Am. J. Dis. Child.*, Jan., 1948, *75*, 81–84.

A case is reported of congenital heart block associated with multiple congenital cardiac anomalies. The congenital anomalies found at autopsy were: transposition of the aorta and the pulmonary artery; absence of the right atrioventricular orifice; septal defect; patent foramen ovale; patent ductus arteriosus; coarctation of the aorta and dilatation and hypertrophy of the left ventricle. This case is regarded by the authors as fulfilling the requirements set forth for the diagnosis of congenital heart block.

The roentgenogram of the chest of the

patient showed an extremely enlarged heart, chiefly to the left. The intrapulmonary vessels were definitely dilated and the aortic knob seemed to be shortened.—*R. S. Bromer, M.D.*

Harvey, W. A. Pulmonary brucellosis. *Ann. Int. Med.*, April, 1948, *28*, 768–781.

Two cases of chronic diffuse pulmonary disease due to brucellosis and a review of the literature are presented. The authors feel that their cases show a characteristic clinical course marked by perihilar lymphadenopathy, bronchitis and pneumonitis of prolonged duration, and usually spontaneous subsidence with resorption or fibrosis. The laboratory findings pertinent to the diagnosis of brucellosis are discussed. In the absence of positive blood culture, it would appear that the diagnosis is not established to general satisfaction unless two of the specific laboratory tests are positive, although there are many published reports in which the diagnosis has been accepted on the basis of the skin test alone, or positive agglutination alone. Beatty is quoted as describing the roentgenological findings as those of hilar infiltration, peribronchial infiltration, thickened pleura, pleural adhesions, and pleural effusion. Harvey's cases show early perihilar and peribronchial infiltration and evidence of persistent fibrotic changes. The difficulty in differential diagnosis from pulmonary tuberculosis is emphasized. Both of these cases were considered to be strongly suspicious of pulmonary tuberculosis. Complete laboratory studies over a prolonged period are recorded. Serial chest films in both cases are reproduced.—*Eugene J. McDonald, M.D.*

Dickie, Helen A., and Clark, Elizabeth A. Histoplasmin and tuberculin sensitivity in relation to pulmonary calcifications among University of Wisconsin students. *Ann. Int. Med.*, June, 1948, *28*, 1087–1093.

The highest incidence of pulmonary calcifications has been found in the central eastern half of the United States. These areas are not closely correlated with the areas of highest mortality from tuberculosis. Because a number of reports have demonstrated that a large number of these individuals had negative tuberculin reactions, a search for a non-tuberculous etiology was started. The authors quote much of the earlier work in histoplasmin sensitivity and present results of a routine survey of 5,000 University of Wisconsin students. These students had photofluorogram and tuberculin tests. One hundred sixty were tuberculin negative, but had pulmonary calcifications. Sixty-six out of 73 who had pulmonary calcifications were histoplasmin positive and tuberculin negative.

Although Wisconsin is an area of comparatively low incidence of histoplasmin sensitivity, the general pattern of the occurrence of pulmonary calcifications is the same as for areas of higher incidence, that is, calcification is two to four times as frequent in the histoplasmin reactor as in the tuberculin reactor. The fact that histoplasmin sensitivity does not necessarily mean that the infective agent is *Histoplasma capsulatum* is well recognized. However the high degree of correlation between histoplasmin reactions and pulmonary calcifications suggests that these calcifications are the result of previous infections with *Histoplasma capsulatum* or a very closely related fungus.

The incidence of pulmonary calcifications of the entire group surveyed and studied was 38.3 per cent in the students reacting only to histoplasmin and 9.2 per cent in those who reacted to tuberculin alone. Small pulmonary infiltrates, indistinguishable roentgenologically from tuberculous lesions, may be associated with histoplasmin sensitivity and not tuberculin sensitivity. In this series coccidioidin skin testing was not done routinely.—*Eugene J. McDonald, M.D.*

Biggs, A. D., and Rigby, R. C. Nontuberculous pulmonary calcification. *J. Pediat.*, April, 1948, *32*, 393–396.

Evidence has accumulated in recent years to disprove the conception that pulmonary calcifications are pathognomonic of tuberculosis. The authors found a group of 14 children in an out-patient department with negative tuberculin tests and pulmonary calcifications. All children were negative to PPD in both first and second test strengths. Bronchoscopic secretions were also negative by direct smear, culture and guinea pig inoculations for tuberculosis.

One patient had acid fast bacilli in aspirated secretions which were attributed to Boeck's sarcoid. All patients showed calcified hilar nodes on roentgen examination and one patient had calcifications in the right third anterior interspace. Six of the 12 patients examined had positive histoplasmin skin reactions. Eight of the 13 patients had changes in the bronchial mucosa.

The authors concluded that tuberculosis is not the only important cause of pulmonary calcifications. Histoplasmosis and recurrent respiratory infections may be other causes.—*Rolfe M. Harvey, M.D.*

MANN, L. T. Spontaneous disappearance of pulmonary metastases after nephrectomy for hypernephroma. *J. Urol.*, April, 1948, *59*, 564–566.

The spontaneous disappearance of metastases in the lungs secondary to hypernephroma is rare. The author summarizes the reported cases and adds that of a sixty-two year old male who complained at the time of hospitalization of progressive weakness, weight loss, and productive cough. Roentgenogram of the chest showed multiple nodular densities varying from 1.4 cm. in diameter. Routine studies to show the source of the primary tumor disclosed a mass lesion of the lower pole of the left kidney by intravenous urography.

The pathological report of the specimen following nephrectomy was hypernephroma. A subsequent film of the chest, seven weeks later, showed more extensive metastases. Eighteen months later a chest film was entirely negative, the metastatic nodules having completely disappeared. The author has no explanation to offer for this.—*Rolfe M. Harvey, M.D.*

GILBERT, R., and VOLUTER, G. Morphologie radiologique pulmonaire d'un granulome histiocyto-éosinophile de la machoire inférieure et de la calotte cranienne. (Pulmonary roentgen manifestations of an eosinophilic granuloma of the mandible and cranial vault.) *J. de radiol. et d'électrol.*, No. 11–12, 1947, *28*, 465–467.

The authors present a case of eosinophilic granuloma of the mandible and frontal and parietal bones with associated roentgen changes demonstrated in the lung fields. They believe this to be the first instance of parenchymal lung changes associated with eosinophilic granuloma of bone in the world literature. The patient was a Polish Israelite, aged twenty, who had spent most of World War II in a concentration camp. The patient presented himself to the Dental Clinic (University of Geneva) for a localized tumor of the right mandible. Other bone lesions were found in the frontal bone and the posteroinferior portion of one of the parietal bones. The lung changes were discrete miliary, soft lesions, with those in the interior basilar portions resembling "the branches of a fir-tree" by their superposition and their number. The miliary seeding having the character of soft granules of small caliber produced practically no interstitial tissue reaction and no coalescence. The patient had a right pneumothorax of about one-third of the three right lobes at the time of the chest film and the authors assume a possible rupture of a subparietal-pleural lesion. There were no clinical symptoms referable to the lungs—subjectively the pulmonary lesions were completely silent. The authors propose the name "eosinophilic granuloma of the lung" for the roentgenological pulmonary findings in this case.

One must remember that the pulmonary lesions were not examined histopathologically and that the roentgen diagnosis of the chest lesions in this case is by exclusion of other possible causes of soft miliary lesions in a patient with biopsy report of eosinophilic granuloma of bone from the mandible biopsy.—*William M. Loehr, M.D.*

DICKIE, H. A. Spontaneous mediastinal emphysema and spontaneous pneumothorax; a report of 20 cases. *Ann. Int. Med.*, March, 1948, *28*, 618–629.

The rapidly increasing number of case reports indicates that spontaneous mediastinal emphysema is not rare. From the University of Wisconsin's Student Health Service, in a four year period, 6 cases of spontaneous pneumothorax without recognized mediastinal emphysema, 7 cases of pneumomediastinum without recognized pneumothorax, and 7 cases in whom the two conditions were associated, are reported. Case summaries of the 14 with mediastinal emphysema are presented. Despite repeated examinations by roentgenograms and fluoroscopy, mediastinal air could be demonstrated in only 3 instances. The clinical diagnosis was made by physical signs of a crunching sound synchronous with the heart beat, along with hyperresonance over the precordium. None of the group showed any physical evidence of subcutaneous air. Inability to demonstrate air in the mediastinum is expected, unless it is localized or relatively large in amount. Only 4 out of the 20 cases were tuberculin positive. One case had roentgen evidence of emphysematous blebs. No roentgenograms are reproduced.

Treatment in this series was symptomatic, and the course was in general benign. With

early ambulation, no complications were reported in the 14 cases of mediastinal emphysema.—*Eugene J. McDonald, M.D.*

ABDOMEN

STRASSMANN, GEORGE S. Relation of acute mucosal hemorrhages and ulcers of gastrointestinal tract to intracranial lesions. *Arch. Neurol. & Psychiat.*, Feb., 1947, *57*, 145–160.

The records of approximately 1,400 autopsies were reviewed in an effort to tell how frequently and under what conditions acute mucosal hemorrhages and erosions of the gastrointestinal tract may be observed with and without fatal intracranial lesions. Twenty-six patients with acute hemorrhagic ulcerations and 30 patients with softenings and perforations of the esophagus, stomach and duodenum are reported. In all but 2, the gastrointestinal lesions were associated with intracranial lesions of various types.

This is a comprehensive article which contains some excellent review of the literature. The author's case histories and photomicrographs support Cushing's contention that erosions and ulcers in the gastrointestinal tract are not infrequently seen in association with various cerebral lesions and after intracranial operations.—*Philip J. Hodes, M.D.*

SCHAEFER, ARTHUR A., and ERBES, JOHN. Hypertrophic pyloric stenosis. *Surg., Gynec. & Obst.*, Jan., 1948, *86*, 45–53.

The authors report on 248 cases of pyloric stenosis seen at Milwaukee Children's Hospital. The majority occurred in first-born males. In 9 instances more than one member of a family was affected.

Biopsies show that the longitudinal as well as the circular smooth muscle fibers are hypertrophied.

The diagnosis rests on the symptoms of (1) projectile vomiting, (2) failure to gain weight and (3) scanty stools and the characteristic physical and roentgenographic findings. Visible peristaltic waves are seen in 83 per cent of cases if the examiner takes the trouble to give the patient a drink of water to stimulate the contractions. A pyloric tumor is present in every case and is pathognomonic if found but may be difficult or impossible to feel.

Roentgenologic examination is one of the most important procedures available in the diagnosis and is almost 100 per cent reliable. After a six hour fast the patient is given 2 ounces of formula-barium mixture and observed under the fluoroscope. Roentgenograms are made at five and thirty minutes and at one and two hours if the pyloric canal is not well visualized on the first films. The stenosed pyloric canal casts a typical shadow with a funnel-shaped entrance and a long narrow lumen described respectively as "prepyloric" narrowing and the "string sign." The stomach is lavaged before operation.

Surgical treatment consists of a Fredet-Rammstedt pyloromyotomy using a high right rectus incision so the liver serves to block the intestines from the wound. Preoperative treatment to correct dehydration and routine transfusions of 10 cc. of whole blood per pound of body weight before leaving the operating room are used. Small amounts of water and formula are started one and two hours after operation and the amounts gradually increased until the fifth day when the normal feeding schedule is resumed.

The operative mortality is 3.8 per cent and no death has occurred during the past ten years.—*J. L. Boyer, M.D.*

BAER, P., and SICHER, K. The association of achalasia of the cardia with oesophageal carcinoma. *Brit. J. Radiol.*, Dec., 1947, *20*, 528–532.

The reported incidence of carcinoma of the esophagus associated with achalasia of the cardia varies greatly with various authors. A survey of the available literature reveals only 8 individuals with achalasia who later developed carcinoma of the esophagus. The authors add 1 additional case. The average age of the patients at the time of discovery of the carcinoma is about fifty-five years, and in the usual patient dysphagia begins twenty years previously. Of the 9 patients only 1 was female. The average symptom-free period between treatment of the achalasia and the development of symptoms of esophageal carcinoma is seven years. The subsequent carcinoma develops in the dilated middle third of the esophagus and because of the dilation it may reach a remarkable size before discovery. In some cases the carcinoma may occupy about half the length of the esophagus. Because of the esophageal dilatation none of the patients has marked esophageal obstruction.

The development of the malignancy presumably follows a logical pattern. Stasis of food above the cardia leads to mechanical, thermal

and chemical irritation, eventually producing an esophagitis which, when it is chronic, produces ulceration of the mucous membrane. Reparative attempts produce proliferating papillomatous areas which finally become malignant. Because of this possible sequence of events it would appear advisable to follow patients with esophageal stasis regularly, even in the absence of symptoms.

Both esophagoscopy and roentgen examination are difficult in these patients because of the large amount of retained food, and the esophagus should be carefully emptied. Esophagoscopy is the method of examination which is most reliable in demonstrating the malignancy. The roentgen examination is further hindered by (1) the elongation and tortuosity of the esophagus, (2) the presence of normal esophagus below the lesion which is usually in the middle third, and further by (3) the demonstration of one cause for the patient's symptoms, namely, achalasia. This difficulty exists despite the fact that the involvement with carcinoma is usually quite extensive.

A sixty-eight year old patient is presented who had long-standing achalasia and was symptom free for three years after treatment, and who was seen with a degree of emaciation which could not be explained on the basis of his short history of vomiting. He developed increasing dysphagia for solid food while fluids were tolerated, his vomitus contained a small amount of blood, and he had retrosternal pain. In this individual the extensive carcinoma was well shown by examination with barium.—*E. F. Lang, M.D.*

GROUT, J. L. A. Carcinoma of the stomach. Symposium. I. A radiologist's point of view. *Brit. J. Radiol.*, Dec., 1947, 20, 491–501.

This portion of the interesting symposium consists in groups of case histories and roentgenograms illustrating patients with gastric lesions. They are arranged to contrast the various lesions as to roentgenographic and clinical appearance. For example, 2 patients were described, each with an ulcerated greater curvature. From a purely roentgenological point of view, a mass growing on the greater curvature of the stomach with a central ulceration in the mass cannot be classified as to its malignancy. With a long history and such findings as anemia and occult fecal blood a benign tumor is to be suspected; with a short history and without anemia a cancer is more likely. It is sometimes difficult to differentiate between a mass within the stomach and deformity of the stomach from pressure due to an extrinsic mass. In some cases metastatic neoplastic glands outside the stomach may produce more striking roentgen changes than the primary tumor itself which is within the stomach which gave rise to the metastases.

Two cases are presented illustrating the variation in the appearance of the greater curvature. One patient was seen early in the course of a carcinoma of the greater curvature and the irregularity was thought to be normal. A second patient, with less irregularity of the greater curvature but with more prominent symptoms, was re-examined at a shorter interval and the carcinoma was discovered earlier.

It is sometimes difficult to state whether or not a given ulcer is on the basis of a malignancy. A tendency for the mucosal pattern to converge toward the site of the ulcer suggests an innocent ulcer. Irregularity of the mucosa about the ulcer suggests malignancy. Unfortunately, some malignant ulcers improve both symptomatically and roentgenologically under a course of treatment.

Some overemphasis has been placed upon the value of determining whether or not a given portion of the gastric wall participates in a peristaltic wave. It is probable that peristalsis stops at the site of only an advanced lesion, but when waves pass without interruption it does not necessarily mean that there is no neoplasm; also it is occasionally difficult to detect small interruptions in the peristaltic wave.

In a careful roentgen examination of patients with obscure gastric lesions, consideration of the clinical picture is most important and, in some instances, the patient might be considered neglected if there is no actual conference between the patient's physician and the radiologist.

The reproductions of the roentgenograms in this article are excellent and the grouping of the case reports most instructive.—*E. F. Lang, M.D.*

RODGERS, H. W. Symposium. II. Gastroscopy in the diagnosis of gastric cancer. *Brit. J. Radiol.*, Dec., 1947, *20*, 502–504.

Gastroscopy should logically follow roentgen examination in the routine investigation of dyspepsia, and particularly where a carcinoma is suspected, in order to rule out certain important contraindications to gastroscopy. The

roentgen demonstration of an advanced carcinoma makes gastroscopy unnecessary and dangerous with the possibility of perforation. Atrophy of the esophageal mucosa, which may be shown by roentgen ray, does not contraindicate gastroscopy but calls for great care in passage of the instrument.

Gastroscopy is indicated in a patient clinically suspected of having a carcinoma when the roentgen examination either reveals no lesion or shows a lesion the nature of which is obscure. Gastroscopy also aids in classification of a known ulcer as to benignity or malignancy.

Gastroscopically carcinoma may be divided roughly into four categories. The first includes the cauliflower-like projections of polypoid lesions which, if they are large enough to be diagnosed by roentgen ray at all, are usually diagnosed with accuracy. The second type of malignancy is the carcinoma which shows ulceration. This usually has a raised, irregular edge with a sloughing floor and elevation of the whole ulcer above the surrounding mucosa. The third type is the fibrous ulcer with malignant change. These are the most difficult to classify and vary between the ulcer in which malignancy is demonstrated only microscopically to the ulcer which is obviously malignant initially. Here there is irregular hyperemia of the ulcer margin with some irregularity in outline, with areas of nodularity. The floor of the ulcer may contain a blood clot or necrotic tissue and there may be infiltration of the surrounding mucosa with carcinoma. Unfortunately for the diagnosis, this type of lesion frequently improves with bed rest and dietary management, as benign ulcers do. Repeated examination is the most valuable method we have for diagnosis of this type. The fourth type of malignancy is characterized by submucous infiltration such as is characteristically seen in "leather bottle" stomach.

Frequently the gastroscopist adds considerable information by examining a region which is suspicious roentgenologically. Every gastroscopist has had the experience of discovering carcinomas of the stomach, both large and small, which were unsuspected roentgenologically.—*E. F. Lang, M.D.*

Stewart, Matthew J. Symposium. III. Cancer of the stomach: some pathological considerations. *Brit. J. Radiol.*, Dec., 1947, *20*, 505–507.

The presence or absence of malignancy in a given pathological specimen is usually easy to determine. When both an ulcer and a cancer are present the order of development is difficult to determine in many instances. Ulceration frequently develops in a malignancy and usually can be identified as such. In some cases, however, the ulceration spreads from the malignant base to involve the surrounding normal mucosa with the production of the typical microscopic picture of an innocent ulcer. Conversely, it has been demonstrated histologically that simple peptic ulcers of long standing may precede a malignancy at the same site.

Stewart presents information concerning 51 cases of malignancy developing in an ulcer, collected from a series of 733 stomachs which were examined over a period of nineteen years. In each of the typical cases there is a history of at least two years of gastric symptoms which were without interruption and which were marked by an increase in severity. In the patients with malignant degeneration of an ulcer the range of gastric acidity more closely approximates that of simple chronic ulcer than that of primary carcinoma.—*E. F. Lang, M.D.*

Taylor, Hermon. Symposium. IV. The surgical aspect of carcinoma of the stomach. *Brit. J. Radiol.*, Dec., 1947, *20*, 507–511.

Carcinoma of the stomach is in itself a symptomless disease. The important aids in establishing an early diagnosis are radiology and gastroscopy. Very frequently by the time striking symptoms have developed the lesion is inoperable. Achlorhydria usually indicates that the disease has extended and, in one review, one-half of the cases of early operable carcinoma had a considerable quantity of hydrochloric acid in the gastric juice. The test for occult fecal blood is also unreliable in excluding an early lesion. Radiology and gastroscopy often fail to estimate the operability of a gastric lesion and this question can be finally decided only by the surgeon at the time of the operation.

With various surgeons there are different limits to which a malignancy must spread to be considered inoperable. The question of operability depends not only upon the experience and skill of the surgeon but upon his determination to take serious risks if thereby he can give the patient a chance of cure. The author feels that every risk should be taken to extirpate the neoplasm if there are no distant metastases. The surgeon should be prepared to remove the

whole stomach with its omentum, the spleen, the transverse colon, and the tail or body of the pancreas if these are involved in the mass. Although radical surgery of this type increases the surgical mortality rate, it also increases the total number of survivors.

Carcinoma in the cardiac end of the stomach is a problem by itself and diagnosis is even more difficult than in the case of carcinoma in the distal half of the stomach. Diagnosis is difficult even radiologically or by esophagoscopy. For these reasons, if there is reasonable suspicion of a growth of the cardia an exploratory operation is entirely justifiable. Radical surgery is also very important in this field if cures are to be produced.—*E. F. Lang, M.D.*

Fairchild, G. Cranston, and Shorter, Alan. Symposium. V. Irradiation of gastric cancer. *Brit. J. Radiol.*, Dec., 1947, *20*, 511–521.

Today approximately 80 per cent of cases of gastric cancer are inoperable by the time they are seen surgically. Irradiation has been attempted to aid in the treatment. External irradiation fails because of the deep situation of the gastric tumor, the proximity of other vital organs, and high resistance of gastric cancer to irradiation necessitating high doses. Contact roentgen therapy, radon seed implantation, and intracavitary irradiation have also been used.

In 1935 Fairchild conceived the idea of direct irradiation of tumors exposed temporarily at operation. With newer tubes, which deliver up to 2,000 roentgens per minute, the time of exposure is not prohibitive. The dose can be applied directly to the tumor and its field of spread. The size, shape, and extent of the lesion and the presence and direction of spread can be determined at the time of operation, and the skin is left intact for further irradiation if necessary. The direct irradiation may be done at the time of the original operation or may be done after a primary stage at which any existing obstruction was relieved.

The surgical approach to the lesion must be planned to permit the most advantageous positioning of the tube in relation to the patient and the tumor. Two tubes are used simultaneously, one through the incision and another through the posterior abdominal wall. An average tumor dose of 1,300 roentgens is given with a surface dose of 1,300 roentgens from the tube under the patient and 1,600 roentgens from the tube directly over the lesion. Recently the dose from the upper tube has been increased. There have been remarkably few reactions to the irradiation. The patients usually have merely nausea and anorexia, with vomiting and diarrhea only rarely.

In almost three years 15 inoperable carcinomas of the stomach have been treated by direct irradiation. In 7 of these the irradiation was purely palliative. Of the other 8 cases, 2 died within the first week after the operation, 1 lived twenty-four months, 2 fifteen months, 1 seven months, 1 four months and 1 three months after treatment.—*E. F. Lang, M.D.*

Gutman, R. Les duodénites du point de vue radiologique. (Duodenitis from the roentgen viewpoint.) *J. de radiol. et d'électrol.*, 1946, *27*, 65–68.

The author, one of the foremost roentgenologists of the digestive tract, describes again what he believes are quite definite and characteristic fluoroscopic and film images of the inflamed duodenum without ulcer.

Most frequent is a polypoid image, that is to say, the mucosa is strewn with translucent rounded areas lying in denser background. More rarely the image is speckled, the mucosa presenting small opaque flecks. At other times one observes a cloudy aspect due to disappearance of the folds from edema of them. Occasionally duodenitis may manifest itself as a filiform narrowing over part of the length of the duodenum—a spasm resulting from hypertonicity of the muscularis mucosae. These appearances may be diffuse or localized and may be frequently seen to stop sharply at the level of the ampulla of Vater. He states that concerning differential diagnosis from ulcer, the polypoid defects of duodenitis never resemble ulcer deformity and the images characterized by multiple flecks would have "trop de niches"—too many niches—to be confused with ulcer and for the occasional case where small radiating folds converge toward a fleck in an edematous large bulb of duodenitis, the presence of true ulcer can be determined by light compression and repeated roentgen examination.

The author feels that duodenitis can be diagnosed roentgenologically far oftener than it is and that many cases of epigastric distress and pain bear a false clinical label of ulcer when no ulcer can be demonstrated but when signs of an inflamed duodenum are present.—*William M. Loehr, M.D.*

Lepennetier, F., Morin, G., Grain, R., and Siguier. Étude radiologique d'une tumeur bénigne du bulbe duodénal. (Roentgenologic study of a benign tumor of the duodenal bulb.) *J. de radiol. et d'électrol.*, 1946, *27*, 423–425.

The extreme rarity of tumors of the duodenal cap is well known. Very few observations of benign tumor of the duodenum have been published in France. The case described by the authors was a male, aged seventy-eight, who presented absolutely no symptoms referable to the duodenum. The patient entered the hospital for treatment of cardiac asthma and the duodenal lesion was found in the course of a gastrointestinal study which was undertaken in order that the study of the patient would be complete. A polypoid type filling defect was demonstrated at fluoroscopy and spot films (reproduced in the article) demonstrated an ovoid filling defect with regular margins on the left border of the cap. The patient succumbed after about two weeks from his cardiac and pulmonary difficulties and the authors were able to obtain the anatomical specimen which showed a small pedunculated benign polyp about the size of a large pea and fixed to the anterior surface of the bulb. There was no ulceration. The statistical study of benign tumors of the duodenum made by E. Roelsen (*Acta medica Scandinavia*, 1935) is discussed in relation to the authors' case. Roelsen found only 36 cases in the world literature—medical, surgical and radiological—up to 1935. Twenty-nine were verified and included the following: 19 grouped as adenoma, polyp or papilloma, 7 fibromyomas, 1 hemangioma, 1 tuberculoma, and 1 schwannoma and in the series of Roelsen the mucosa covering the benign tumor was ulcerated in 4 cases.

The great rarity of tumor in the duodenal cap quite naturally makes the roentgenologist hesitant about suggesting this diagnosis.—*William M. Loehr, M.D.*

Mahorner, Howard, and Kisner, Wendell. Diverticula of the duodenum and jejunum with a report of a new technical procedure to facilitate their removal and a discussion of their surgical significance. *Surg., Gynec. & Obst.*, Nov., 1947, *85*, 607–622.

Duodenal Diverticula.

Incidence: Duodenal diverticula are found relatively frequently at autopsy. Various investigators have noted their incidence to vary from 0.5 to 14.5 per cent.

Sex: There seems to be no sex predilection.

Location: Most of the duodenal diverticula occur on the concave side of the descending portion. The majority of them occur in the region of the ampulla of Vater. They usually present posteriorly or into the head of the pancreas.

Next to the perivaterian area the concave inferior transverse portion of the duodenum is the site most often affected. The diverticula here present upward and are covered by the transverse mesocolon and are associated with the ligament of Treitz.

Etiology: The condition is seldom seen early in life; it usually occurs in the fifth, sixth or seventh decade.

Symptomatology: It has been estimated that only 25 per cent of duodenal diverticula are asymptomatic. The most common symptom is pain. Apparently the pain is due to filling and failure of adequate emptying of the diverticulum.

Treatment: When duodenal diverticula are large enough to cause residual pooling of barium removal or inversion is indicated.

Jejunal Diverticula.

Jejunal diverticula are much less common than diverticula of the duodenum and much more difficult to diagnose preoperatively. They may cause severe symptoms and surgical removal of them results in cure.—*Mary Frances Vastine, M.D.*

O'Neill, James F., Anderson, Katherine, Bradshaw, Howard H., Lawson, Robert B., and Hightower, Felda. Congenital atresia of the small intestine in the newborn. *Am. J. Dis. Child.*, Feb., 1948, *75*, 214–237.

The types of congenital abnormalities of the alimentary tract considered in this discussion are the complete intrinsic obstructions of the small bowel. Two general groups of such lesions exist: (1) one or more septums or diaphragms completely occluding the lumen and (2) narrowing of the intestinal diameter at one or more sites to the point of total obstruction. In the latter type, the proximal blind end of bowel may be completely separated from its distal counterpart, or the two ends may be joined with a solid cordlike structure, devoid of a lumen. Therefore, mesenteric defects may or may not occur.

The paper contains a report of 2 cases, with a

review of successfully treated obstructions of the small intestine. Under separate headings the following subjects are discussed: the incidence of gastrointestinal atresia, the occurrence of multiple atresias, the incidence of associated deformities of other organs, the familial tendency to intestinal atresias, etiologic theories of the diagnosis of congenital obstruction of the small intestine, the survival time in cases of untreated atresia, and the mortality rates following surgical correction of atresia. In the final portion of the paper the authors discuss and record the cases of successfully treated congenital atresia of the small intestine and report 2 additional cases of their own.

The importance of congenital atresia of the small intestine is much greater than the incidence of the condition would tend to indicate because it is so amenable to surgical treatment. In most children the atretic lesion is the only abnormality present, so that its correction should restore the patient to complete normality.

The nature and location of the opaque areas seen on the preoperative plain roentgenograms of both patients reported are of great interest, in view of Neuhauser's opinion that such areas are typical of the presence of fetal meconium peritonitis. In both infants, a diagnosis of meconium peritonitis could not be made with certainty, for even though the second patient had peritoneal adhesions present, no yellowish plaques of old meconium were present on the peritoneal surfaces. Furthermore, these calcified areas were not present on plain roentgenograms made four days after either operation. It seems probable that in the 2 patients the calcified material was within the intestinal lumen, although this is not entirely certain.

The authors suggest that the high mortality still current even among infants in the hands of excellent pediatricians and pediatric surgeons is due to the fact that many of these patients do not reach them until relatively late in the course of the disease.—*R. S. Bromer, M.D.*

GYNECOLOGY AND OBSTETRICS

ALLEN, E. PETER. Standardised radiological pelvimetry. IV. Interpretation of pelvimetry. *Brit. J. Radiol.*, May, 1947, *20*, 205–228.

The ability to measure the maternal pelvis by roentgen methods has been perfected to such a degree that it is a reliable means of obtaining the exact bony measurements. The fetal skull cannot be measured so accurately, and its other characteristics, such as compressibility, ability to rotate, and variation in soft tissues, make prediction of the course of labor from roentgen studies still a matter of judgment. By correlating the course of labor with certain features of the pelvis, as shown in roentgenograms, one should be able to arrive at a basis for prediction.

A series of pelves was measured and the course of the subsequent labor was followed with careful notation of factors such as fetal size, length of the three stages, the condition of the child after delivery, and in the case of surgical intervention, whether this was done because of mechanical disproportion or some other factors. The measurements were grouped according to whether or not delivery through that pelvis was normal or abnormal.

As might be expected, the true conjugate was the most useful single diameter in predicting the course of labor. On the other hand, the area of the inlet, or the area of the midplane of the pelvis each permitted more accuracy in prediction than any single diameter. The figures arrived at through an analysis of many cases indicate when a normal delivery is to be expected. These figures should be used for prediction when the child is of average size and when there is no other factor which might indicate abnormality other than mechanical obstruction. With a small baby delivery might occur through a pelvis which would be called abnormal in other circumstances. For the figures arrived at here the average fetal skull is taken as 100 mm. in diameter, and variations from this should alter the prognosis.

Vaginal delivery is predicted as certain when the conjugate is over 130 mm., or when the brim area is over 130 sq. cm. Cesarean section is considered justified when the conjugate is under 90 mm. and the brim area is under 85 sq. cm.—*E. F. Lang, M.D.*

HARTNETT, LEO J. The possible significance of arterial visualization in the diagnosis of placenta praevia. *Am. J. Obst. & Gynec.*, June, 1948, *55*, 940–952.

The author performed aortograms on 68 women during the later stages of pregnancy without serious complications.

Sodium iodide, 80 per cent, and diodrast, 70 per cent, were used in this series. The patients were routinely carefully checked for sensitivity to the contrast substance before the procedure was carried out.

The puncture of the aorta was performed on the roentgen table. With the patient lying prone under intravenous pentothal sodium anesthesia, the aorta was punctured and the contrast medium injected. As a rule, 10 cc. of sodium iodide or at least 18 cc. of diodrast were injected into the aorta within a period of about five seconds. Sodium iodide seemed to cause considerable irritation of the arterial bed with contraction of the uterus. The latter were not observed when the sodium iodide was injected more slowly or when diodrast was used. The first exposure was made as the injection was completed and the second within seven seconds of the first.

Extravasation of the injected solution was one of the more common complications occurring in 13 of the 68 women injected. This was followed by some lumbar pain and a slight febrile reaction which lasted for one or two days.

Visualization of the placenta was excellent. The maternal circulation was clearly defined. The placenta was characterized by the appearance of multiple collections of the radiopaque substance irregularly distributed throughout one portion of the uterus. Instead of the usual appearance of blood vessels, there were many large lake-like collections which the author refers to as "mottling."

Two patients with bleeding were studied by this technique and, in both, a placenta previa was encountered.

This is an interesting article which contains seven excellent illustrations showing the apparatus and the resulting roentgenograms.—*Philip J. Hodes, M.D.*

Sun, Ko-Chi. The characteristics in hysterosalpingograms in tuberculous salpingitis and endometritis. *Am. J. Obst. & Gynec.*, June, 1948, *55*, 953–960.

The present observations are based upon the author's findings in 6 patients who proved to have tuberculous salpingitis and endometritis at operation.

Three distinct and constant features were found in all of the patients examined by hysterosalpingography.

First, the lipiodol revealed defective nonhomogeneous filling of the cervical canal and uterus. The lipiodol in the cervical canal revealed a fuzzy contour, whereas its outline was shaggy and irregular in the uterus.

Second, the fallopian tubes appeared like thin, stiff wires with irregular sacculations near the fimbria. The fimbria were pouch-like and saccular. Not infrequently the contrast medium appeared uneven simulating radiopaque foreign bodies.

In the third place, lipiodol never appeared free in the peritoneal cavity.

Excellent roentgenograms document this communication. In addition, the author briefly reviews the differential diagnosis of hysterosalpingograms.—*Philip J. Hodes, M.D.*

GENITOURINARY SYSTEM

Coliez, Robert. Les signes radiologiques de stase et de suppression urétero-rénale au cours de l'urographie intra-veineuse. (Roentgen signs of stasis and ureterorenal suppression during intravenous urography.) *J. de radiol. et d'électrol.*, No. 7–8, 1947, *28*, 311–342.

The second report presented before the Fifth Congress of French Speaking Radiologists is a masterful presentation of all diagnostic aspects of intravenous urography complete to the minutest detail, from the nature of renal elimination of contrast substances to every type of characteristic pyelographic deformity due to urinary stasis which can be demonstrated by this method.—*William M. Loehr, M.D.*

Herbst, W. P., and Bagley, C. E. Observations on the use of inositol in advanced malignancy of the genito-urinary tract. *J. Urol.*, April, 1948, *59*, 595–598.

Inositol is an experimental compound from the vitamin B complex group. It is normally found in plant and animal cells. It exists in several forms. The compound is stable, water soluble and has a sweet taste. Considerable experimental work has been done on the various forms of inositol in varied conditions.

Seven cases of terminal malignancy of the genitourinary tract were given inositol in doses of 2–4 grams daily. The drug had no effect on these cases, which included carcinoma of the prostate, carcinoma of the penis, and seminoma of the testicle. The drug was then tried in 5 cases of carcinoma of the bladder and some benefit was noted in control of hematuria and reduction in tumor size. The drug also appeared to be beneficial in a case of hypernephroma of the kidney.—*Rolfe M. Harvey, M.D.*

Schmidlapp, C. J., II, and Marshall, V. F. The detection of cancer cells in the urine; a clinical appraisal of the Papanicolaou method. *J. Urol.*, April, 1948, *59*, 599–603.

The Papanicolaou vaginal smear method has been useful in detecting cancer of the vagina, cervix and uterus. The test depends on the exfoliation of tumor cells. The authors have applied the method to the urinary tract. Their present series of cases now includes 333 patients. They found the method to be valueless in benign tumors whose cells did not deviate from the normal sufficiently to make their recognition possible. In the case of malignant tumors, smears from the first urine sediment examined were usually positive although in some cases numerous examinations were required.

Dr. Papanicolaou personally examined all smears. The cases were grouped into clinically cancerous, clinically suspicious and clinically non-cancerous. The laboratory reports were rendered as laboratory cancerous, laboratory suspicious and laboratory non-cancerous.

One hundred ninety-eight cases were reported laboratory non-cancerous, of which 88 per cent were clinically non-cancerous, 4.1 per cent clinically suspicious and 7.1 per cent clinically cancerous. All of the latter group were proved cancerous.

Fifty-three cases were laboratory suspicious; 45.3 per cent of these were clinically cancerous, most of these having positive biopsies.

Eighty-two cases were laboratory cancerous; 86.5 per cent of these were clinically cancerous and one additional 8 clinically suspicious. There has been no instance of a false positive report. In 3 cases, bladder cancers, which had not been suspected clinically, were found after thorough investigation following a positive laboratory report.

This study indicated that the Papanicolaou smear method was of most value in cases of bladder cancer. Care must be exercised in reporting abnormal cells where a cancer patient is receiving hormonal therapy. The finding of malignant cells after all visible cancer has been removed probably indicates residual disease and has prognostic significance.—*Rolfe M. Harvey, M.D.*

Chute, R., and Williams, D. W. Experiences with stained smears of cells exfoliated in the urine in the diagnosis of cancer of the genito-urinary tract; a preliminary report. *J. Urol.*, April, 1948, *59*, 604–618.

The present study was undertaken with a view to determining the possible value of the Papanicolaou stained smear method in detection of malignancy as a possible screening test for mass survey work. The authors made a single modification of Papanicolaou's method by centrifuging an entire fresh specimen of urine and then fixing the sediment with 95 per cent alcohol.

Experience in examining the slides is essential. In the present series the authors insisted on a definite diagnosis based on tissue examination or adequate clinical grounds. The slides were scored as positive, doubtful, or negative. One hundred ninety-four specimens from 168 different cases were considered as satisfactory for the examination; 109 had no malignant disease and 88 per cent were correctly diagnosed negative and 12 per cent incorrectly called positive.

In 59 patients with malignancy of the genitourinary tract 55 per cent were correctly diagnosed by the smear method. In the entire series 77 per cent were correctly diagnosed either positive or negative. The authors found that the more malignant the tumor as far as the bladder was concerned, the more apt it was to be diagnosed by the smear method. This did not hold true for prostatic cancer.

In explanation of the 12 per cent false positives the authors feel that increased experience may help to prevent some of the errors. Apparently chronic inflammatory disease of the genitourinary tract may produce transitional epithelial cells.

The fact that multiple smears are frequently required for a diagnosis militates against the use of the method for mass screening.—*Rolfe M. Harvey, M.D.*

Hickel, R. Les signes radiologiques des tumeurs rénales bénignes et malignes. (Roentgenological signs of benign and malignant tumors of the kidney.) *J. de radiol. et d'électrol.*, No. 3–4, 1947, *28*, 94–103.

The author gives a complete essay on the different abnormal images of the kidney and deformations in the pyelogram characteristic of the most common benign and malignant kidney tumors. The illustrative pyelograms are excellent and there are 16 black and white drawings diagramming pyelographic deformities resulting from different locations of tumors

within the kidney. This is an excellent reference article for teaching.—*William M. Loehr, M.D.*

Campbell, M. F. Bilateral embryonal adenomyosarcoma of the kidney (Wilms' tumor). *J. Urol.*, April, 1948, *59*, 567–571.

Most cases of bilateral Wilms' tumor are not true primary lesions but represent metastases from a single primary to the opposite kidney. True bilateral primary Wilms' tumors are a rarity. The author reports 2 such cases.

The first patient was an eighteen month old infant in whom a left-sided abdominal mass had been discovered. An intravenous urogram confirmed the presence of a left-sided abdominal tumor mass with no identifiable excretion of dye from the left kidney. The right kidney showed compression of the upper and middle calices. No function could be demonstrated from the left kidney after complete urological investigation. Bilateral retrograde pyelography confirmed the findings in the right kidney and showed no demonstrable left kidney pelvis or upper ureter. The preoperative diagnosis was polycystic disease.

At operation it was immediately apparent that the left kidney was the site of a tumor and not polycystic disease. A left nephrectomy was performed. The pathological diagnosis was Wilms' tumor. Three weeks after operation the right kidney was explored and also found to be the site of a malignant tumor. Postoperative roentgen therapy was ineffective.

The second case was diagnosed at postmortem on a twenty-four day old infant dying of inanition.—*Rolfe M. Harvey, M.D.*

Kretschmer, H. L. Renal rickets and polycystic disease of the kidney. *J. Urol.*, May, 1948, *59*, 773–783.

Primary or secondary renal disease leading to prolonged renal dysfunction may result in rachitic bone changes.

The author reports the case of a five month old infant in whom abdominal examination disclosed the presence of a bilateral palpable mass. The child had taken cod liver oil and tomato juice since the age of three weeks. The blood pressure on admission was 180/90. Roentgen studies of the long bones were negative. An intravenous pyelogram showed no visualization of the genitourinary tract. The heart was enlarged. A preoperative diagnosis of polycystic disease of the kidneys was made, and confirmed by operation and biopsy.

Approximately three years later the child showed definite evidence of dwarfism and clinical evidence of rickets. Roentgen examination showed osteoporosis, thinning of the cortices and "deformity" of the metaphyses. The roentgen changes were said to be "not that of infantile rickets."

Among the theories proposed to explain the syndrome called variously renal rickets, renal dwarfism, renal infantilism, and so forth, are the following:

1. Renal theory. In advanced renal destruction the kidneys cannot excrete waste phosphorus. This phosphorus is excreted then through the intestinal mucosa. This interferes with calcium absorption and leads to depletion of bone calcium.

2. Parathyroid theory. Some authors feel that the syndrome is a result of primary hyperparathyroidism and the kidney condition is due to secondary calcification and fibrosis in the kidneys. The distinction between primary hyperparathyroidism and renal rickets depends upon whether or not skeletal changes antedate or follow renal changes. Some experimental evidence exists that renal insufficiency leads to secondary hyperplasia of the parathyroids.

3. Pituitary-diencephalon theory. This theory best explains the dwarfism, infantilism and polyuria.

4. Acidosis. This theory would explain all changes on a basis of chronic acidosis resulting from renal insufficiency.—*Rolfe M. Harvey, M.D.*

Hoffman, H. A. Massive hydronephrosis. *J. Urol.*, May, 1948, *59*, 784–794.

Statistics indicate that the diagnosis of massive hydronephrosis is missed in approximately 1 out of every 3 cases. The commonest confusing condition is ovarian cyst. Only 89 cases of massive hydronephrosis had been reported up to 1947. The author feels that the condition is much more common than this would suggest and found 10 cases in a review of the case records of the Massachusetts General Hospital from 1941–1946, inclusive. He arbitrarily makes the diagnosis of massive hydronephrosis when the capacity of the kidney exceeds 1,000 cc.

The author summarizes his 10 case reports, including illustrative films. In his series males were affected in the ratio of 4:1 as compared with females.

The commonest complaint was flank or loin pain. Fifty per cent had palpable masses. Six of the 10 cases had negative urine sediment. The intravenous pyelograms were valueless in all but one case. The retrograde pyelograms were diagnostic in 9 of the 10 cases. In this series the left side was involved in 90 per cent of the cases.

The referring physician had not made the diagnosis in a single instance. Nephrectomy was the treatment employed in all cases.

Massive hydronephrosis is usually congenital in origin. Infection usually prevents the hydronephrosis from becoming massive by directing attention to the condition. Uncomplicated massive hydronephrosis is usually asymptomatic and many cases rupture following abdominal trauma as the presenting symptom. This leads to an erroneous diagnosis of intra-abdominal injury, laparotomy and a mortality rate of 30 per cent. This emphasizes the importance of considering massive hydronephrosis as a differential possibility and thus avoiding improper therapy and unncessarily high mortality. In the author's series, where the correct diagnosis was made preoperatively and the correct therapy employed, there was no mortality.—*Rolfe M. Harvey, M.D.*

Higgins, C. C., and Hausfeld, K. F. Cutaneous metastases from vesical carcinoma of the urinary bladder; report of two cases. *J. Urol.*, May, 1948, *59*, 879–886.

Skin metastases from vesical carcinoma are rare. The greatest primary source of skin metastases, with a 16 per cent incidence, is breast cancer. The authors have been able to find only 8 reported cases of bladder carcinoma with skin metastases. They report an additional 2 cases.

The mechanism of the metastases is not known but is thought to be by the blood stream to the skin lymphatics. The authors feel that there must be more unreported cases and make a plea for their publication for better evaluation of bladder carcinoma and its therapy.—*Rolfe M. Harvey, M.D.*

Hovenanian, Michael S., and Deming, Clyde L. The heterologous growth of cancer of the human prostate. *Surg., Gynec. & Obst.*, Jan., 1948, *86*, 29–35.

The authors present the results of transplantation of carcinoma of the human prostate into the eyes of guinea pigs. They were able to grow the tumor successfully and make successive transplants for six serial generations. Throughout all of these the cellular morphology of the parent human tumor was maintained, thus proving this cancer to be truly an autonomous growth.

Testosterone or one of its constituents appears essential to the growth of prostatic cancer, for successful "takes" occurred only in normal male animals or in females stimulated with testosterone in tremendous dosage. Transplants failed to grow in castrated males and in normal females. Increasing the amount of testosterone in the males did not increase the rate of tumor growth.

The inherent ability of the prostatic cancer cells to produce acid phosphatase disappeared on transfer as demonstrated by an absence of elevation of blood phosphatase in the tumor-bearing animals and absence of stain for phosphatase in tissue sections.—*J. L. Boyer, M.D.*

Wear, J. B., and Schoenberger, A. P. Carcinoma of the prostate; a twelve year review. *J. Urol.*, April, 1948, *59*, 587–594.

This report is based on a study of 400 cases of prostatic carcinoma seen during a twelve year period; 170 cases had metastases when first seen. The symptoms, physical findings and methods of treatment are all summarized in this report through a series of charts.

Roentgen treatment was used in 54 cases. In 25 cases it was the only form of treatment. The average survival time in these 25 cases was eleven months. Roentgen radiation was never used as a curative procedure. In 50 per cent of the cases roentgen therapy improved the pain of metastatic lesions, for varying periods of time.

The authors state that roentgen therapy will have only a minor role in this disease in their practice in the future, estrogens and orchiectomy having priority. Up to 80 per cent of cases in this series showed favorable response to estrogenic therapy. Orchiectomy is used only in patients with objective evidence of metastases.—*Rolfe M. Harvey, M.D.*

Lewis, L. C. Testis tumors; report on 250 cases. *J. Urol.*, April, 1948, *59*, 763–772.

The authors report on a series of 250 cases of testicular tumors seen at the Walter Reed Hospital. Forty-three per cent had metastases on admission and an additional 28 per cent developed metastases eventually.

The author suggests the following classification of testicular tumors based on embryonal form, pathological structure, radiosensitivity and results of combined surgical and radiation treatment:

A. Tumors of supporting tissues of testis
 1. Cysts of tunica albuginea
 2. Fibromas
 3. Fibrosarcomas
 4. Fibroleiomyosarcomas
 5. Hemangiomas
 6. Endotheliomas
B. Tumors of interstitial cells
C. Tumors of germ cell origin
 1. Seminomas (dysgerminoma, spermatocytoma)
 2. Carcinoma
 a. undifferentiated carcinoma
 b. adenocarcinoma
 c. papillary adenocarcinoma
 3. Trophocarcinoma
 a. choriocarcinoma (form of cytotrophoblast)
 b. chorioepithelioma (form of syncytiotrophoblast)
 4. Teratocarcinoma
 a. teratoma with carcinoma, undifferentiated, adenopapillary
 b. teratoma with choriocarcinoma
 c. teratoma with chorioepithelioma
 5. Teratoma
 a. immature
 b. mature
 c. rhabdomyosarcoma

Group A, tumors of the supporting tissues, are similar to those produced in other parts of the body. Group B, the specific endocrine tumors, are usually benign. The seminoma is histopathologically identical to the ovarian carcinoma. It is slow growing, has delayed metastases, is very sensitive, and has a good prognosis. Forty-three per cent of the tumors in this series were of this variety. Fifteen per cent of this group had metastases on admission. This is the common tumor of the atrophic testicle.

The author states that the lethal dose for mature teratoma cannot be reached with safety by roentgen irradiation.

The symptoms for all tumor groups consist early of painless swelling which may become painful later. Symptoms referable to metastases may be present

The diagnosis is based on bimanual palpation, roentgen examination and, if there is still doubt, by exploration.

The author favors radical orchiectomy for any type of testis tumor. The main exception might be the very radiosensitive seminoma. Radical orchiectomy consists in removing the testis with its tunica, the epididymis, vas, entire spermatic cord and the retroperitoneal lymph nodes from the inguinal ring to the renal pedicles.

The author found roentgen therapy to be effective only if a full lethal dose was used.

No difficulty was encountered in giving a lethal dose with the million volt unit, but care must be exercised for the normal overlying skin. Fourteen patients in this series had perforations of the bowel or stomach, eighteen to twenty-four months following therapy. A lethal dose for seminomas is 1,000 r. Prophylactic irradiation for tumors requiring more than 3,000 r lethal tumor dose is not safe.

Thirty-two per cent of the total series have died, 8 having died from perforation of the bowel or stomach due to excessive irradiation.

The author concludes that simple orchiectomy is sufficient for benign interstitial tumors; radical orchiectomy without roentgen therapy is required for teratomas; simple orchiectomy plus roentgen therapy with 1,000 r delivered to the retroperitoneal nodes is sufficient for seminomas; radical orchiectomy plus prophylactic roentgen therapy up to 3,000 r is required for undifferentiated carcinoma, adenocarcinoma and papillary adenocarcinoma; and, for trophoblastic tumors, radical orchiectomy plus heavy roentgen therapy, when inoperable metastatic nodes remain, should be used.—*Rolfe M. Harvey M.D.*

NERVOUS SYSTEM

Cross, Glen O. Subarachnoid cervical angioma with cutaneous hemangioma of a corresponding metamere. *Arch. Neurol. & Psychiat.*, Sept., 1947, *58*, 359–366.

The importance of recognizing that a relationship may exist between developmental anomalies of the skin and coexisting abnormalities of other ectodermal derivatives is emphasized by this author. The literature obtaining to cutaneous angiomas, lipomas, and vascular tumors associated with similar spinal cord lesions is reviewed. Concerning vascular tumors, the author quotes Cushing and Bailey who pointed out that the skin and other organs lying in the same segment of nerve distribution may often be affected when a vascular abnormality of the central nervous system exists. The fact that patients with nevi of the face may have

associated intracranial vascular tumors is recalled to mind.

The author reports his findings in a patient with a hemangioma of the skin of the left side of the neck and prominent vascular markings of the skin of the upper part of the chest who developed pain, motor weakness and paralysis due to an extensive subarachnoid angioma in the lower cervical spine. The vascular tumor extended from the lower cervical region up into the posterior fossa of the skull. The vessels contained mixed arterial and venous blood. The cord appeared compressed and flattened. The larger blood vessels seemed continuous with the vessels in the spinal cord. The tumor could not be removed but the symptoms regressed following the decompression.—*Philip J. Hodes, M.D.*

French, J. Douglas. Recurrent arachnoiditis in the dorsal spinal region. *Arch. Neurol. & Psychiat.*, Aug., 1947, *58*, 200–206.

The author presents 4 cases selected from 8 cases of dorsal arachnoiditis in whom the diagnosis was verified at operation twice.

The clinical course of spinal arachnoiditis seems to be characterized by an exacerbation and remission of symptoms. Neurologic residua are noted later suggesting a chronic progressive process. The first patient suffered periods of pain, numbness and incomplete paralysis on five different occasions during a period of nineteen years. With time, the attacks became more severe and associated with persistent disability. During one remission, the spinal fluid protein remained markedly elevated for about twelve days whereas seven years later, during another attack, the spinal fluid protein was normal. This patient's myelogram revealed no abnormalities and the patient was not operated upon.

The second patient had many attacks of arachnoiditis over a period of fourteen years, supposedly associated with repeated pulmonary infections. In this patient, too, the spinal fluid protein was found increased during several attacks. A myelogram revealed a partial block in the upper dorsal region which at operation proved to be due to cystic arachnoiditis. This patient improved following surgery.

The symptoms in the third patient were of but two months' duration. This individual, a diabetic, also suffered pain, numbness, weakness and altered reflexes. During the acute phase of his illness, the spinal fluid protein was 400 mg. whereas three days later, it dropped to 100 mg. and a week later, 15 mg., coincident with the patient's improvement. A recurrence of symptoms several weeks later was again associated with a marked rise in the spinal fluid protein to 600 mg. A myelogram revealed marked irregularity and fragmentation of the pantopaque column in the mid-dorsal region. At operation, the arachnoid was found thickened and adherent to an atrophic appearing spinal cord.

The history in the fourth patient also indicated an acute exacerbation and remission of spinal arachnoiditis eleven years after operation for an epidural abscess. This patient's spinal fluid protein was also markedly elevated to 375 mg. A myelogram revealed a complete block at the level of the first lumbar vertebra. Improvement was spontaneous and the patient was not operated upon.

The evidence suggests that spinal arachnoiditis is an acute recurring process which becomes chronic only when organized adhesions or cysts have formed, producing irreversible changes in the spinal cord. Changes in subarachnoid pressure and in the chemical content of the spinal fluid appear to follow promptly these fluctuations in symptoms.—*Philip J. Hodes, M.D.*

Adams, Raymond D., and Wegner, Walter. Congenital cyst of the spinal meninges as cause of intermittent compression of the spinal cord. *Arch. Neurol. & Psychiat.*, July, 1947, *58*, 57–69.

The author describes 2 unusual patients with intermittent compression of the spinal cord due to a teratomatous cyst in the meninges. The first patient had suffered five attacks of pain in the back and partial paraplegia with sensory loss and sphincteric disorder. The second patient had also had five attacks of pain in the neck followed by hemiplegia or quadriplegia, sensory impairment, paralysis of the bladder and rectum and respiratory embarrassment. The first patient's illness covered a period of thirteen years while the second patient's symptoms occurred intermittently during a period of six years.

The cerebral spinal fluid protein was increased in both patients. In one patient, a definite dynamic block was demonstrated in the spinal canal.

Both patients were operated upon and in one,

the cyst was partially removed and in the second, it was completely removed with excellent therapeutic results. Microscopic examination of the cysts demonstrated their teratomatous character.

The long history with intermittent periods of compression of the spinal cord characterized this lesion. The evidence suggests that the intermittent character of the symptoms may be the result of intermittent swelling of the cyst with compression of the spinal cord.

Both patients revealed spinal cord blocks by pantopaque myelography. Sharply defined filling defects in the oil column characterized their roentgen appearance. Some thinning of the laminas of the affected segments of the spine was noted at operation in one patient.—*Philip J. Hodes, M.D.*

Lipin, Theodore, and Davison, Charles. Metastases of uterine carcinoma to the central nervous system. *Arch. Neurol. & Psychiat.*, Feb., 1947, *57*, 186–198.

Metastases from carcinoma of the uterus to the central nervous system are infrequent. When present, they may be solitary lesions or they may occur associated with widespread metastatic disease.

The authors report 3 patients with metastatic brain tumors from adenocarcinomas of the fundus of the uterus.

The first patient developed her metastatic brain lesion one year following her hysterectomy. There was no other evidence of malignant disease in this patient.

The second patient developed a cerebellar metastatic nodule five years after her original hysterectomy. This patient had evidence of disseminated carcinomatosis from a uterine malignancy.

The third patient also developed her brain metastasis five years following surgery. She too revealed evidence of disseminated metastatic disease.

The percentage of uterine carcinomas metastasizing to the central nervous system varies from 0.1 to 3.4 per cent according to different authors. The authors believe that neurosurgery is definitely indicated in patients with metastatic carcinoma of the brain if the metastasis is apparently solitary.—*Philip J. Hodes, M.D.*

Gillespie, H. W. Further observations on the radiological diagnosis of lumbar intervertebral disc lesions. *Brit. J. Radiol.*, Jan., 1947, *20*, 37–40.

A previous communication has shown the use of myelography unnecessary in the diagnosis of a prolapsed lumbar intervertebral disc, as the diagnosis can be established by clinical observations and by plain roentgenograms. The two principal findings are decreased intervertebral spacing and hypertrophic fringe formation. In over 50 per cent of cases of disc lesions narrowing of the involved space can be demonstrated.

An attempt has been made to determine how early a decreased intervertebral disc space can be shown after a traumatic episode. There are two ways to show this. A comparison of preoperative and postoperative roentgen studies when some disc material has been removed shows further decrease in the spacing as early as four weeks after laminectomy.

The second method is estimation of the interval between the onset of pain and the time of roentgen demonstration of the decreased space. In a series of 100 patients 70 per cent were able to give not only the date of onset of the pain but the cause. Twenty-five per cent gave no history of injury but could state the onset of sudden pain. All 100 patients in this series were subjected to operation on the basis of clinical and roentgenographic findings, and in 92 the operative findings corresponded with the preoperative roentgen findings.

The time interval between the onset of pain and roentgen evidence of decreased intervertebral disc spacing varied between one month and twenty-seven years. In 16 of the 92 cases there was a time interval of five months or less.—*E. F. Lang, M.D.*

SKELETAL SYSTEM

Pyle, S. Idell; Mann, Arvin W.; Dreizen, Samuel; Kelly, Harriet J.; Macy, Icie G., and Spies, Tom D. A substitute for skeletal age (Todd) for clinical use; the red graph method. *J. Pediat.*, Feb., 1948, *32*, 125–136.

The red graph method is a graphic means of expressing skeletal development. The name is derived from the color graph paper used in constructing the original graph. The graph was composed during the revision of Todd's "Atlas of Skeletal Maturation." The red graph method differs from the Todd graph in that the latter averages development of the various bones of a skeletal unit and expresses this average in the

form of a single line chart whereas the red graph method plots zones including the earliest and most advanced bone age represented in a skeletal unit. The red graph method thus will better express the developmental symmetry of a functional skeletal unit.

Todd's original standard was based on the fact that bone growth consists of a series of histological changes in cells whereby bone salts are modelled into cortex. Both the Todd and red graph methods consist of a series of roentgenograms to portray the successive steps, or skeletal maturity indicators, through which the articular cortex of the bone and the epiphyseal cartilage plate progress to form adult bone joints. The speed of these changes is a measure of the child's growth.

The reason for development of the red graph method as a refinement of the Todd graph is that the Todd graph is an average and discounts the development of the most delayed bones obscuring the site of tissue strength and weakness. By use of the red graph the assigned age of every bone will fall within the zone of the graph.

The authors include graphs of 3 children to illustrate how the red graph is constructed and its practical clinical employment.—*Rolfe M. Harvey, M.D.*

Shuman, H.H. Infantile cortical hyperostosis. *J. Pediat.*, Feb., 1948, *32*, 195–202.

The author reports an additional case of the syndrome originally described by Caffey. His patient was a four months old male infant who was admitted to the hospital for fever, irritability and brawny facial edema. The patient had had adequate nutrition and had been in good health prior to the onset of the present illness. Ten days before admission he developed what appeared to be a typical upper respiratory tract infection with fever, irritability and rhinitis. The day before admission a bilateral brawny swelling of the lower jaws developed.

Penicillin and sulfadiazine did not affect the course of the disease. An elimination diet was also tried without avail. Roentgen studies of the mandibles on admission were negative. After four weeks a tender swelling appeared over the left clavicle. Roentgenograms at this time showed typical changes in both clavicles, several ribs and both mandibles. There was no evidence of pleural effusion. Illustrative films are included.

Subsequent studies showed gradual improvement in the bone lesions although fever persisted for six months. No etiological agent was discovered.

The author calls attention to the fact that the child's growth was uninterrupted throughout the course of the disease.

The characteristic roentgen changes consist of external cortical thickening of the affected bones, which may or may not be laminated, and extends the whole length of the bone shaft. Involvement of the mandibles is almost a prerequisite for the diagnosis.—*Rolfe M. Harvey, M.D.*

Herdner. Le sternum de l'enfant. Frequence actuelle de troubles de développement révélés par l'examen radiographique. (The infant sternum; present incidence of disturbance of development revealed by roentgen examination.) *J. de radiol. et d'électrol.*, No. 9–10, 1947, *28*, 387–393.

The author points out the high frequency of developmental disturbances seen in the ossification centers and later in the asymmetric development of the manubrium and body of the sternum in children studied during 1946. The author considers the sternum a "test bone" for study of growth and development. Abnormalities in size, shape and contour of the manubrium and segments of the body of the sternum of varying degrees are discussed and illustrated. In many instances in the author's cases the changes were first picked up on chest films of infants and young children.—*William M. Loehr, M.D.*

Smith, Frederick M. Monteggia fractures; an analysis of twenty-five consecutive fresh injuries. *Surg., Gynec. & Obst.*, Nov., 1947, *85*, 630–640.

In 1814 Monteggia was the first surgeon to describe 2 cases of fracture of the shaft of the ulna associated with which there was an anterior dislocation of the head of the radius. This combination of injuries has since been commonly called a Monteggia fracture.

Though not a common one the injury is also not a rarity, yet it might seem so if one were to count only the fresh cases that come to the clinic for treatment. It is an extremely important type of injury because of the fact that the true diagnosis is often completely missed on clinical and even on roentgen examinations. To over-

look the associated radial head dislocation results in inadequate treatment, continued dislocation, possible ugly and permanent deformity, loss of lateral stability at the elbow, restriction of function, and oftentimes pain.

Summary.

1. Early recognition of the radial head dislocation is the most important part of the diagnosis in Monteggia fractures.

2. Early treatment with completely perfect reduction of the fracture as well as the dislocation is necessary and this must be checked frequently by roentgenograms to rule out secondary loss of position of either bone.

3. Open reduction is frequently necessary if the ulnar fragments cannot be held in anatomical position.

4. Open reduction is often absolutely necessary to make possible reduction of the radial head and for removal of interposed ligament or capsule.

5. If open reduction is to be performed, it should be done early and preferably with rigid internal fixation applied to the ulna.—*Mary Frances Vastine, M.D.*

Hughes, E. S. R. Painful heels in children. *Surg., Gynec. & Obst.*, Jan., 1948, *86*, 64–68.

The author takes issue with the diagnosis of osteochondrosis of the epiphysis of the os calcis in painful heels in children. The roentgenographic signs usually taken to indicate epiphysitis such as enlargement of the epiphysis, irregularity, fluffy appearance, etc., as well as several abnormal appearances of the epiphyseal line and the metaphysis of the os calcis are explained on the basis of the development of the bone and its normal variants.

This study of the roentgenograms of 39 painful adolescent heels in conjunction with the normal series fails to show evidence of epiphysitis or osteochondrosis. Also, follow-up examinations revealed no residual anatomical abnormalities. The author concludes that there is insufficient proof that osteochondrosis is ever the underlying cause of adolescent painful heels.—*J. L. Boyer, M.D.*

Abeshouse, B. S. Heterotopic bone formation following suprapubic prostatectomy. *J. Urol.*, Jan., 1948, *59*, 50–66.

The author classifies extraskeletal heterotopic bone formation as follows:

1. Periosteal type (involvement of bone without soft tissue extension).

2. Fascial type (primary involvement of fascial tissues with subsequent involvement of adjacent muscle tissues but no demonstrable bone connection).

3. Muscular type (involvement limited to muscles with no demonstrable bone connection).

4. Combined form (the most frequent).

Few reports of heterotopic bone formation following abdominal operations exist and still fewer reports following suprapubic operations on the bladder and prostate. The author was able to find only 17 case reports of the latter in the literature.

It has been experimentally demonstrated by Strauss and others that the epithelium of the upper urinary tract has unusual osteogenetic properties. The chief histopathological changes consist of the development of an epithelial-lined cyst in twenty days and bone formation in sixty days. Heterotopic bone formation of this experimental type is supposedly due to metaplasia of the proliferating epithelium and surrounding connective tissue. Other theories offered as to the occurrence of heterotopic bone formation following suprapubic prostatectomy include neurogenic, metabolic, chemical irritation, neoplastic, traumatic, inflammatory and periosteal. The author favors the metaplastic theory.

The heterotopic bone may be found superficially in small masses or more deeply in the fascial coverings of the rectus muscle and may or may not be attached to the symphysis pubis. The bone masses may be single or multiple. Usually the bone is true cancellous bone.

The masses may be asymptomatic or the patient may complain of pain and functional urinary disturbances. Usually a firm or stony hard mass can be palpated in the region of the operative scar.

The diagnosis is made on the history of a preceding operation, palpation of a mass and roentgenograms of the pubic area. The latter may show a tumor of bone density, the relationship to the pubis being demonstrable by stereoscopic anteroposterior, lateral or oblique views.

The differential diagnosis must include foreign bodies, osteitis of the pubis, hematoma, of the muscles, malignancy of the pubis, faulty healing of pubic fractures, congenital skin osteoma and calcification or ossification in malignant tumors.

The treatment is surgical excision. No recur-

rences have been reported. The author includes the eighteenth reported case with a roentgenogram to show the typical roentgen appearance. —*Rolfe M. Harvey, M.D.*

ROENTGEN AND RADIUM THERAPY

Figi, Frederick A. Hemangiomas of the mouth. *Ann. Otol., Rhin. & Laryng.*, Dec., 1947, *56*, 853–866.

This is a very satisfactory review of hemangiomas of the mouth which includes comments concerning their pathology, physical characteristics, and treatment.

The strawberry type of capillary hemangioma is lined with an infantile form of endothelium because of which these growths respond well to irradiation. The author prefers a screened radium plaque.

Because the blood vessels in port wine stains are lined with an adult type of endothelium, these lesions are not benefited by roentgen therapy. The author advises the use of cosmetics to conceal the blemish.

Cavernous hemangiomas respond well to irradiation. The author uses radon seeds containing from 0.25 to 0.1 millicurie each implanted into the tumor and spaced approximately 1 cm. apart. Roentgen therapy or radium packs are used to supplement the interstitial irradiation. In adults, however, cavernous lesions are more effectively treated with electrocoagulation or an injection of boiling water or chemical sclerosing agents. The plexiform or racemose hemangiomas are more difficult to obliterate than the simple cavernous hemangiomas because of the greater amount of blood coursing to the part. Though more common in adults, these lesions occur frequently in infants. Early in life, interstitial irradiation has been used effectively. In adults, lesions of this type with only a slight impulse are often treated with electrocoagulation. Usually, these lesions require ligation of the afferent vessels in addition to the usual measures employed in the treatment of cavernous hemangiomas.

Hemangiomas about the jaws often contain phleboliths which may cause considerable discomfort. These calculi are easily palpable and may be removed with surprisingly little bleeding.—*Philip J. Hodes, M.D.*

Gilbert, René. La roentgenthérapie de la douleur. (Roentgen therapy of pain.) *J. de radiol. et d'électrol.* No. 7–8, 1947, *28*, 343–353.

The author discusses the use of roentgen therapy in the treatment of pain and devotes considerable space to a study of the mode of action of roentgen radiation on pain. Use of roentgen radiation in treating pain is divided into following categories: (1) treatment of pain in cases in which cause of the pain is known—inflammations, acute or chronic, neoplasms, vasomotor disturbances, and (2) treatment of pain in cases in which the cause is unknown, for example neuralgias or so-called essential neuralgias. Each type and subtype of clinical cause of pain is discussed from the point of view of therapy factors used to obtain an analgesic effect. Of interest is a table of results obtained in treating sciatic neuralgia with the rays directed at different segments of the spine from T10 to L3 only, T10–L3 plus L4–S2, L4–S2 only, T10–L3 plus peripheral distribution of sciatic, T10–L3 plus L4–S2 plus periphery, and peripheral distribution of sciatic only. Sixty-eight per cent of cases were cured when treatment was directed through T10–L3 only. Only 2 cases were relieved by directing through L4–S3 only. Field size of 17 by 8 cm. on each side of midline of spine at level of T10–L3 and rays directed obliquely inward at angle of 20 to 25°; 160 kv. (peak), 0.5 mm. Cu plus 1 mm., Al, distance 40 cm., 3 treatments per week, 6–8 treatments total; dose per treatment 125 r (in air on skin), total of 1,500 to 2,000 r for each region irradiated.—*William M. Loehr, M.D.*

Hahn, P. F., and Sheppard, C. W. The therapeutic use of radioactive elements in malignancy. *Ann. Int. Med.*, March, 1948, *28*, 598–606.

Isotopes offer much promise in solving the mysteries of metabolic processes in the animal and human body. The authors state that artificially produced radioactive isotopes have opened up such broad horizons in the treatment of malignant disease that they will ultimately in all likelihood far surpass roentgen and radium treatment together in therapy.

Criteria for therapeutic usefulness of radioactive isotopes are cited and include (1) a desirable half-life ranging from two to ten days; (2) biological behavior of the isotope and chemistry of the element should be established and understood; (3) the radiation spectrum should be established and proper cognizance of the rela-

tive beta and gamma radiation which it is desired to deliver to tissue must be taken into account; (4) the radioactive material should preferentially be deposited selectively in the tissues it is desired to treat; (5) if the isotope is toxic, specific activity becomes important in keeping the dosage of material well under toxic limits.

From Seaborg's table of some 450 known radioactive isotopes, a small group are selected for discussion, with the criteria predicated above being the limiting factors. The most striking observation is the paucity of isotopes which hold promise of use as therapeutic agents. Radioactive sodium, phosphorus, manganese, copper, arsenic, yttrium, silver, iodine, and gold are briefly discussed. Suggested techniques in therapeutic use are outlined.

Some of the author's techniques have been given clinical trial, and have shown themselves to be feasible. A few are sufficiently controversial that they require considerable additional analysis.—*Eugene J. McDonald, M.D.*

Huggins, Charles. The chemotherapy of cancer. Editorial. *Surg., Gynec. & Obst.*, Nov., 1947, *85*, 660–662.

At this time it is possible to notice only those chemical methods of treatment which seem to have been well established. They may be divided into 3 groups according to their action.

1. Necrotizing agents. It has long been known that certain bacterial products when administered parenterally to creatures bearing sarcomas produce severe hemorrhage in the tumors within a few hours with subsequent necrosis of the affected area of the neoplasm. The separation of the hemorrhage producing agent in a culture of *Serratia marcescens* (*Bacillus prodigiosus*) from toxic and inert contaminates has been accomplished by Shear and co-workers in a brilliant series of investigations; it has been found to be a polysaccharide which is active in very small amount. Unfortunately, in most cases the necrosis of the tumor is not complete and while certain tumors regress, some of the tumor usually remains viable.

2. Competitive inhibition and the essential foodstuffs. It has been found in cancer of the prostate that androgen is often an essential item for the nutrition of the malignant cell; the tumors grow vigorously when androgen is administered in appropriate dosage and the cells tend to wither when the androgen supply is removed (orchiectomy) or estrogen is administered.

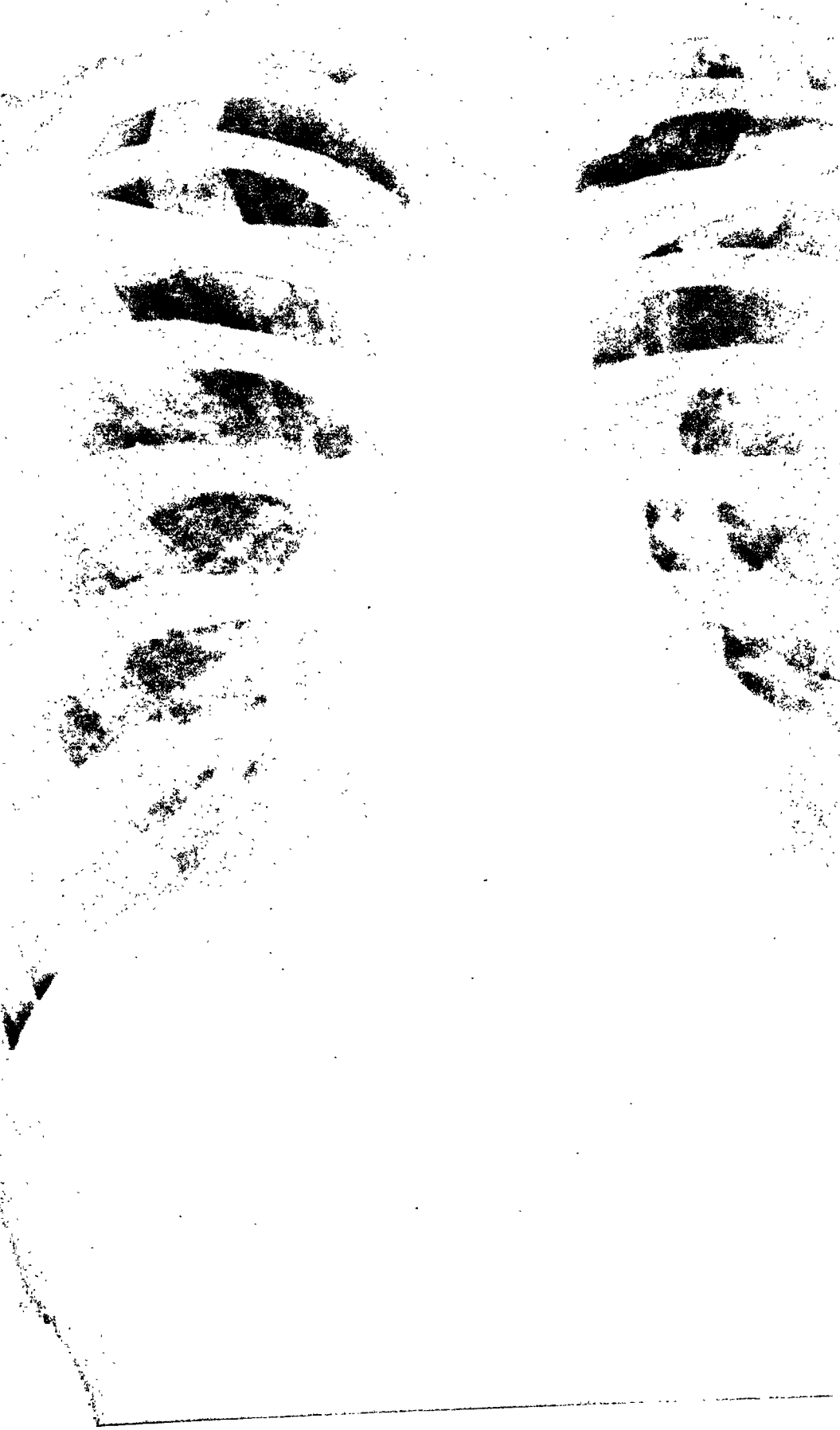
Heilman and Kendall found that the compound E of Kendall derived from the adrenal cortex caused massive involution of lymphosarcomas in female and young male mice. There seems to be a relationship between the adrenal cortex and lymphocytes in that adrenal stimulation causes a decreased activity of lymphoid tissue.

Sulfonamides in proper concentrations have been found to eliminate the effectiveness of p-aminobenzoic acid, a substance essential for the growth of certain bacteria.

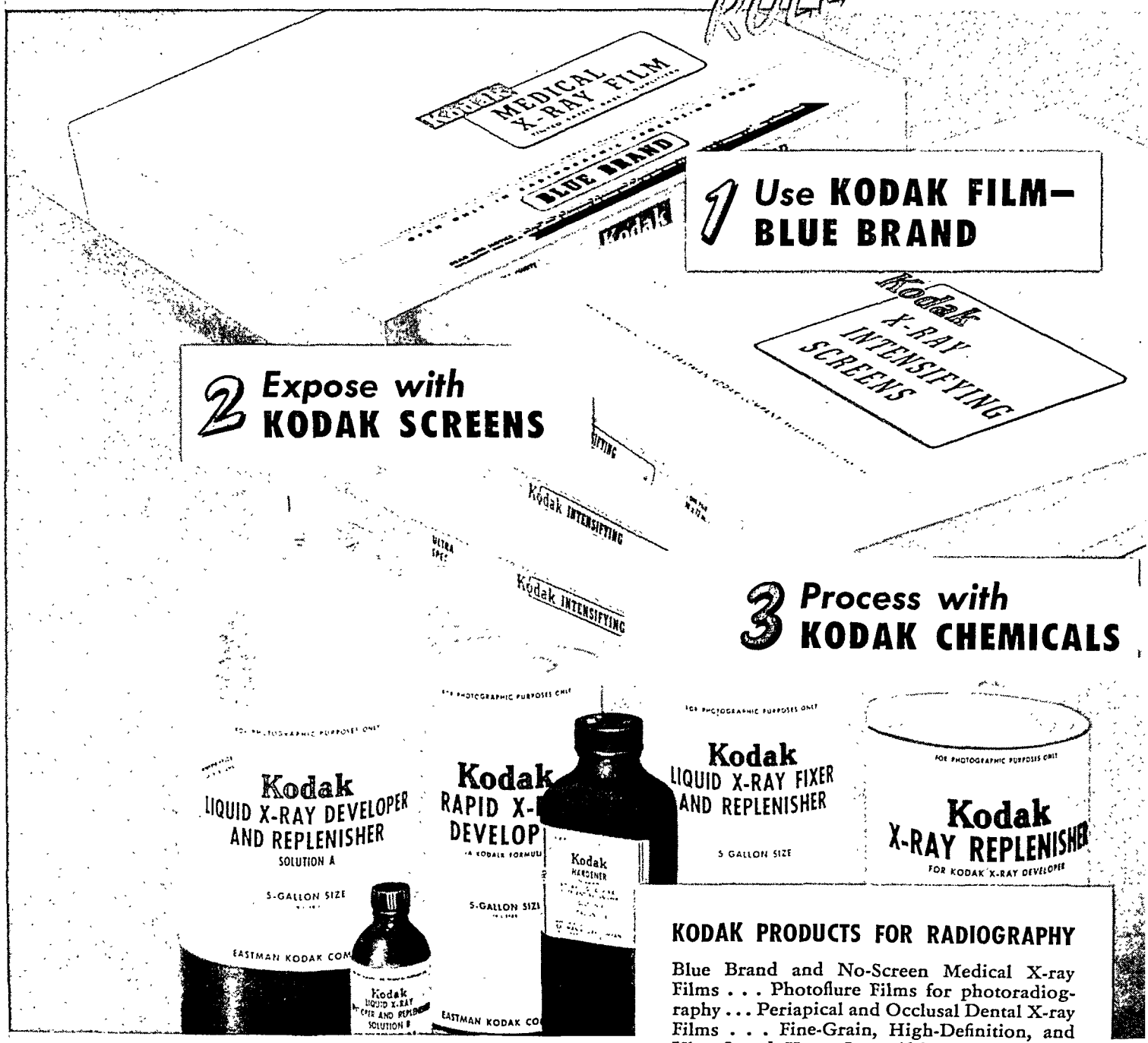
3. Nuclear damage. It has long been established that irradiation damages cells, and because of the frequency of induced mutations as well as much other evidence, the principal effect of irradiation is believed to be on the nucleic acids of the cell nucleus. The radioactive isotopes with a short period of decay constitute a useful method of presenting soluble radioactive chemicals to the organism as a whole. Radioactive phosphorus has great value in chronic lymphatic and myelogenous leukemias and is probably the best therapeutic agent which is now available for polycythemia vera.

The nitrogen mustards have been used in clinical patients in the treatment of Hodgkin's disease and it has been found that regression sometimes occurs after their use. The mustards are the only agents known which can produce mutations chemically, an effect which hitherto has been produced only by radiant energy.

Still another agent capable of producing regressions in cancer is ethyl carbamate (urethane) which has produced regression of transcarcinoma in mice as well as in human leukemia. Urethane can reduce the growth of human prostatic cancer notably in patients where a relapse has occurred after hormonal treatment with orchiectomy and estrogen; the drug is not antiandrogenic and so constitutes a new principle in the treatment of advanced prostatic cancer acting by pycnosis.—*Mary Frances Vastine, M.D.*



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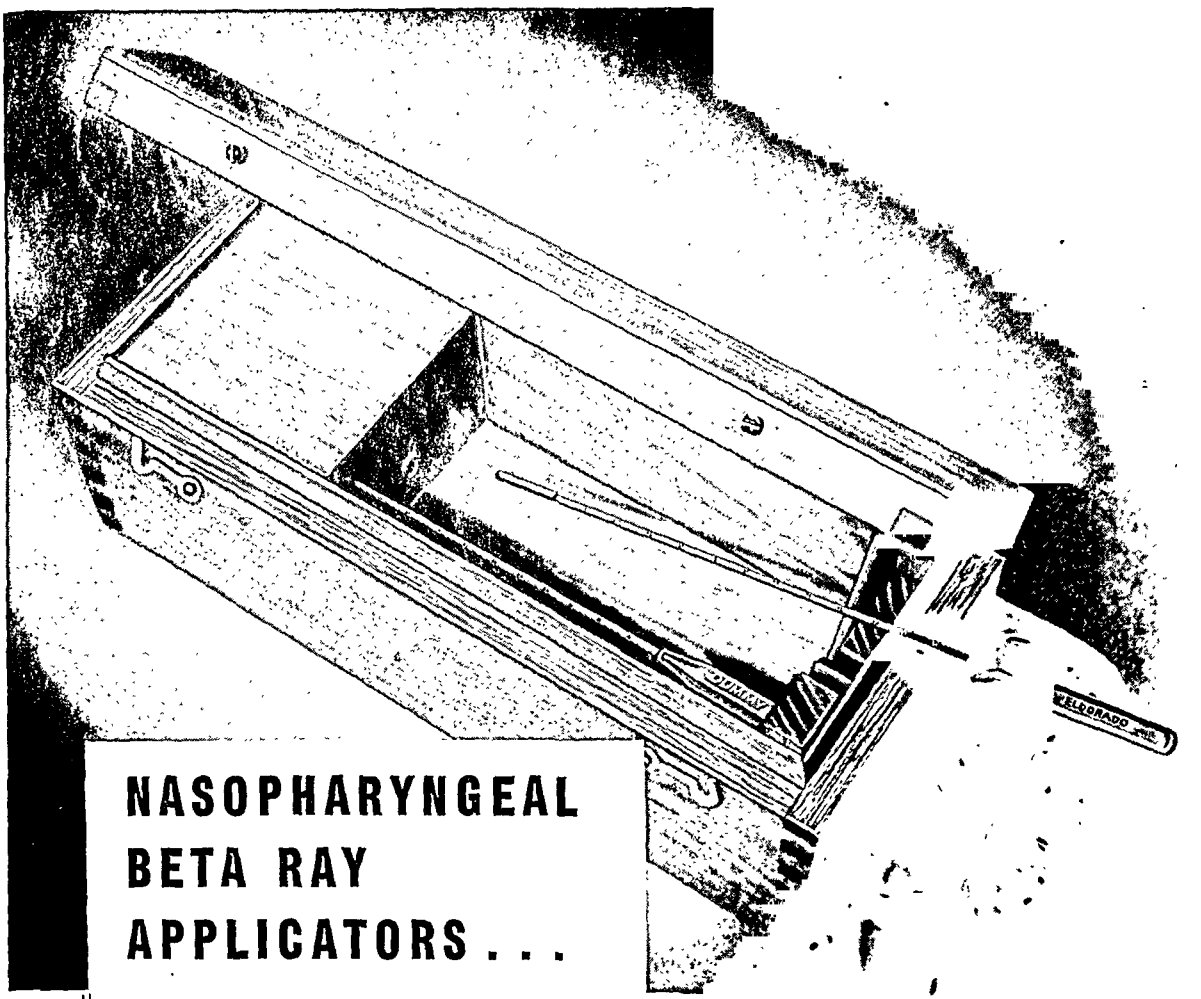
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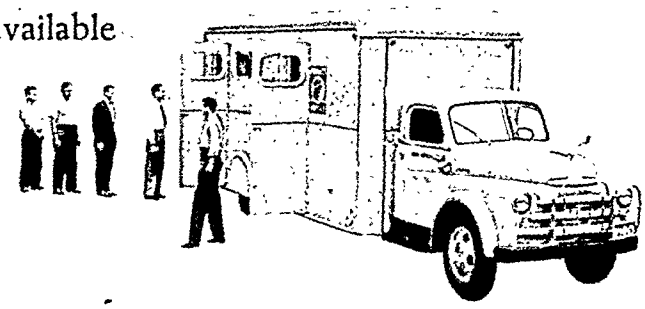
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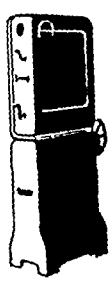


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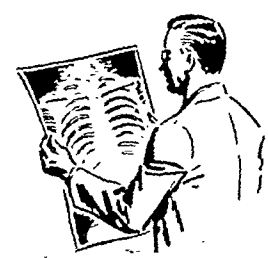


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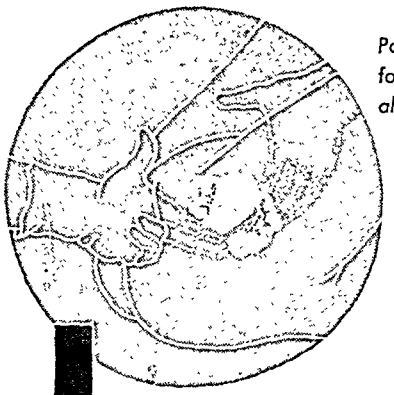
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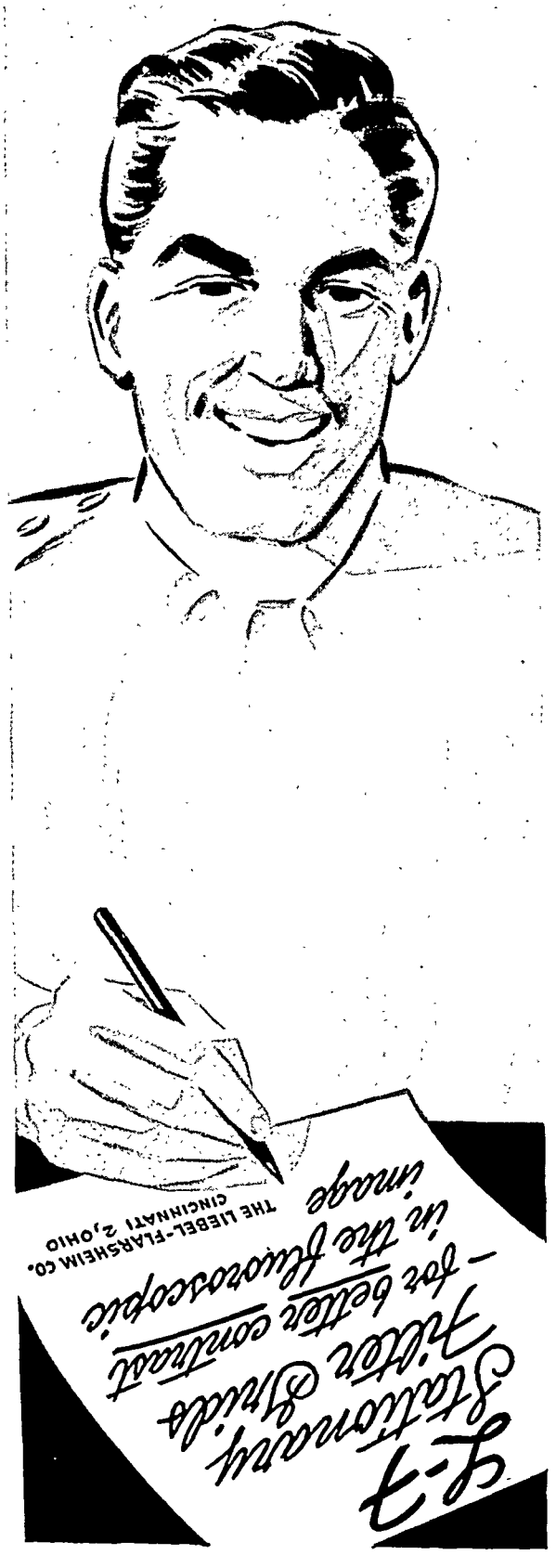


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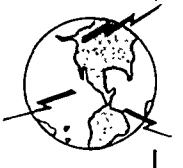
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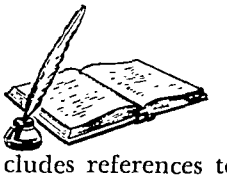
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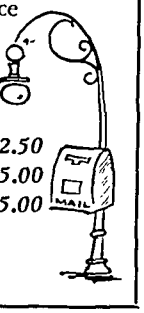




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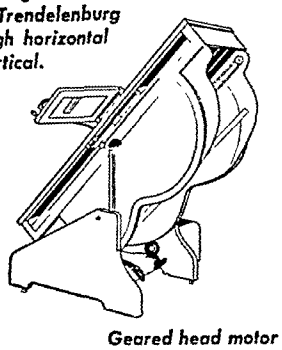
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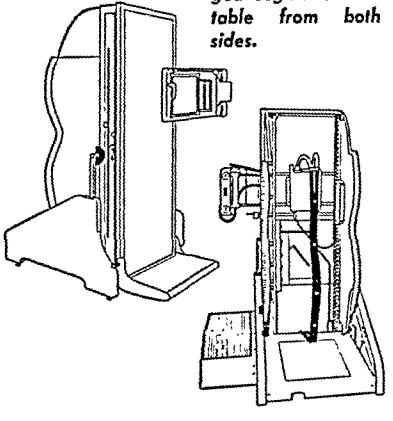
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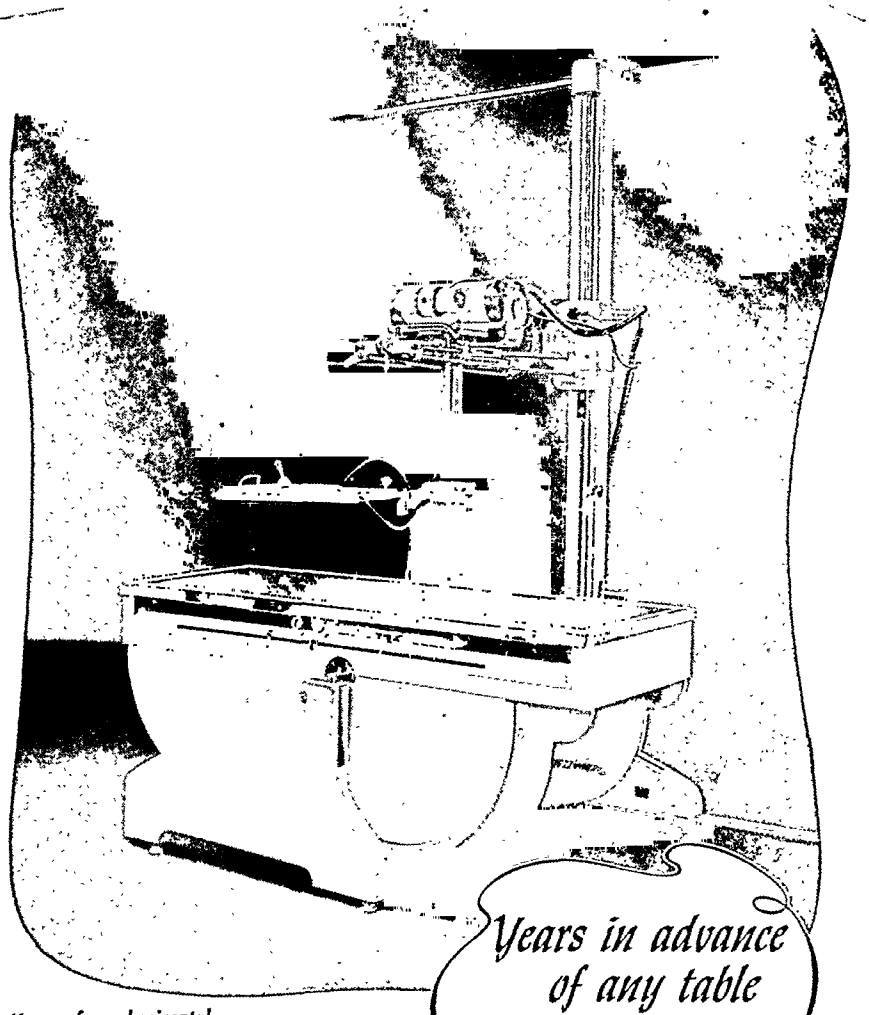
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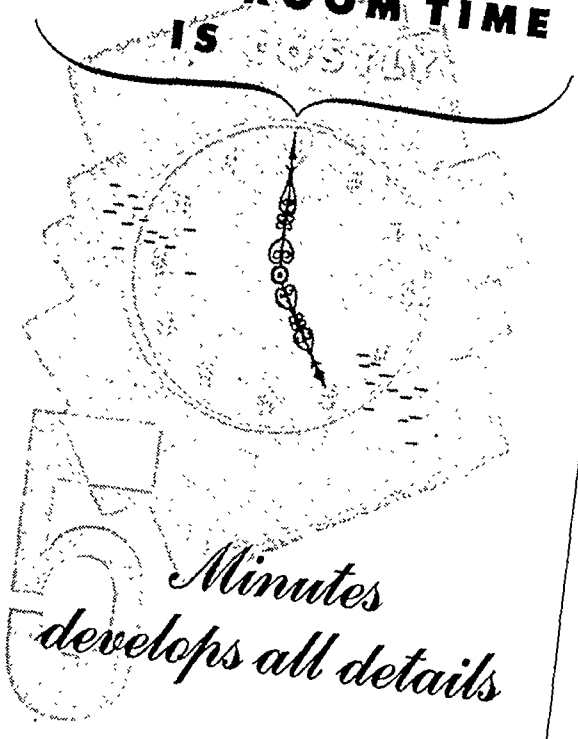
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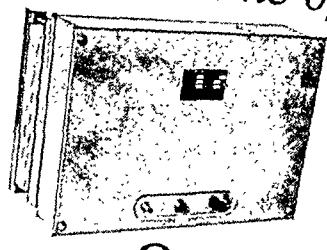
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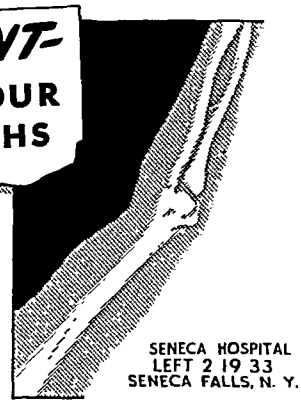
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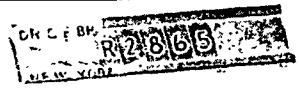
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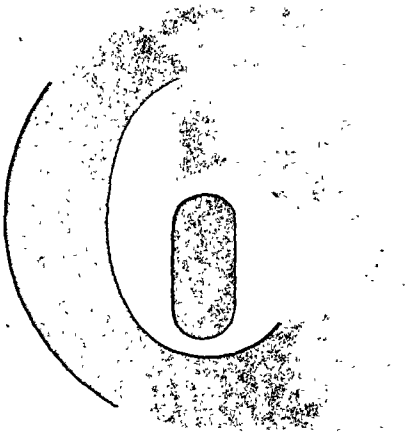
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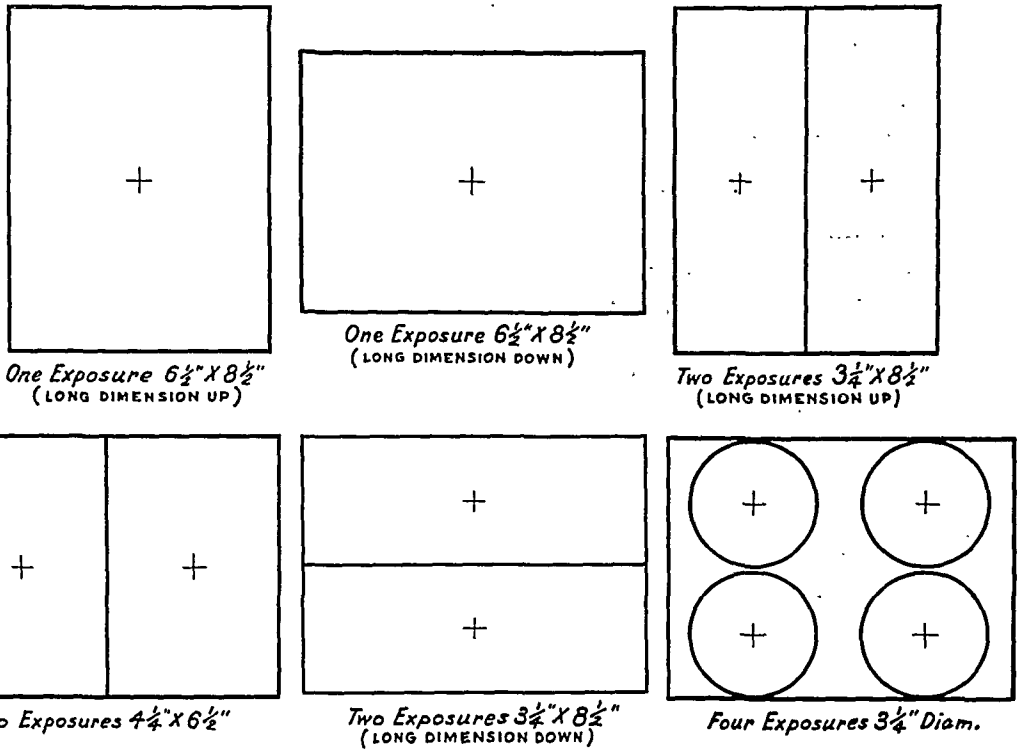
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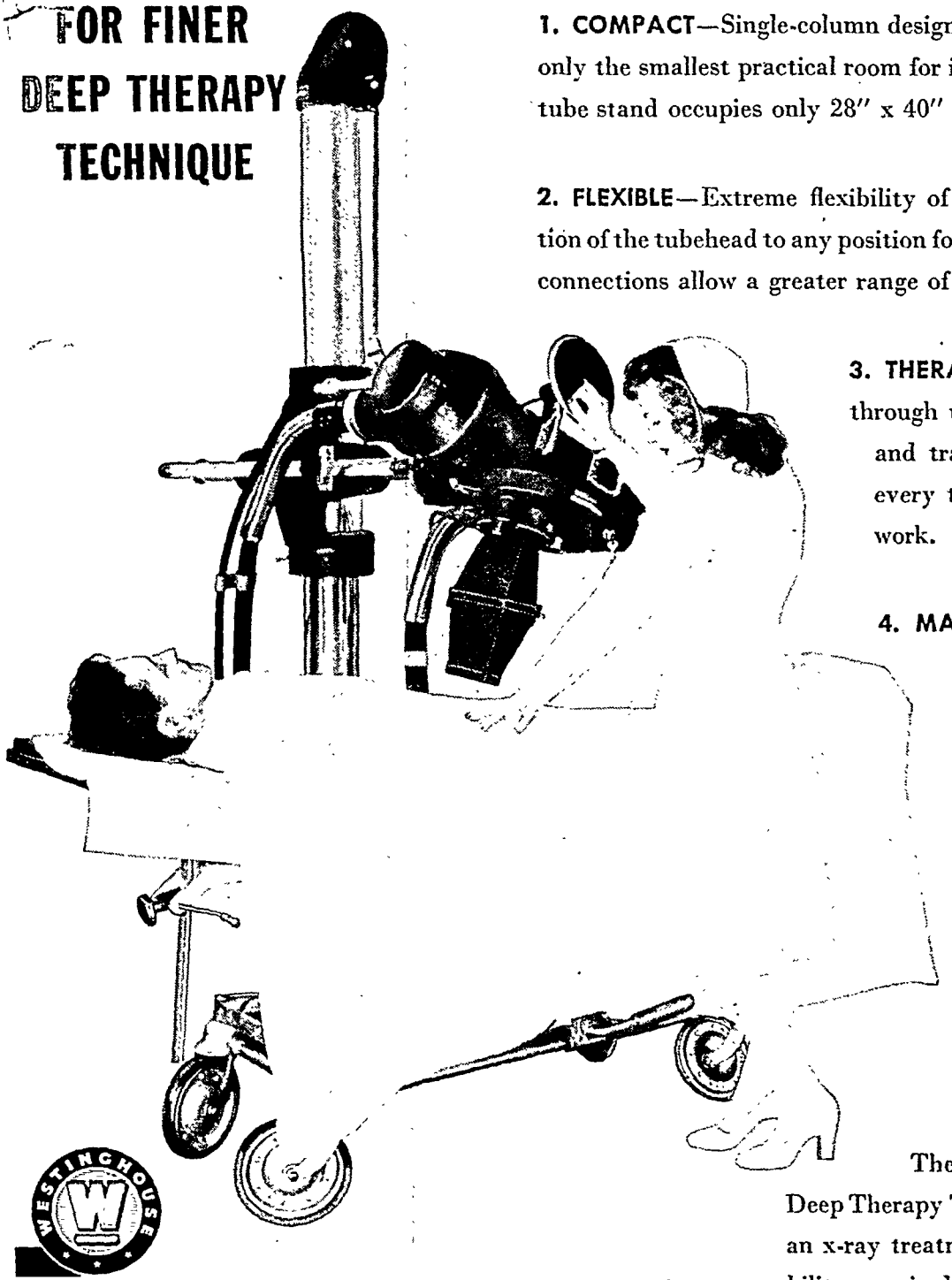
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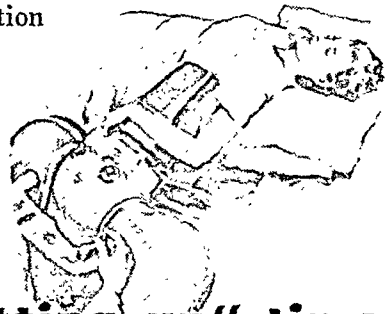
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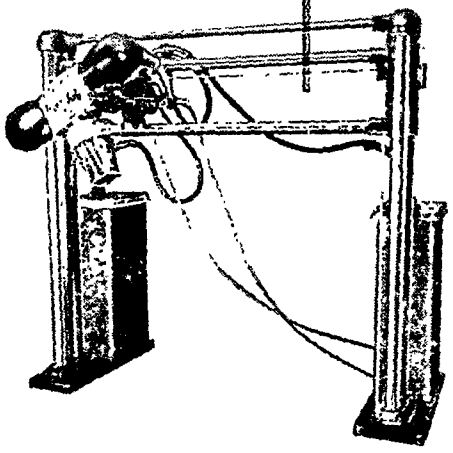
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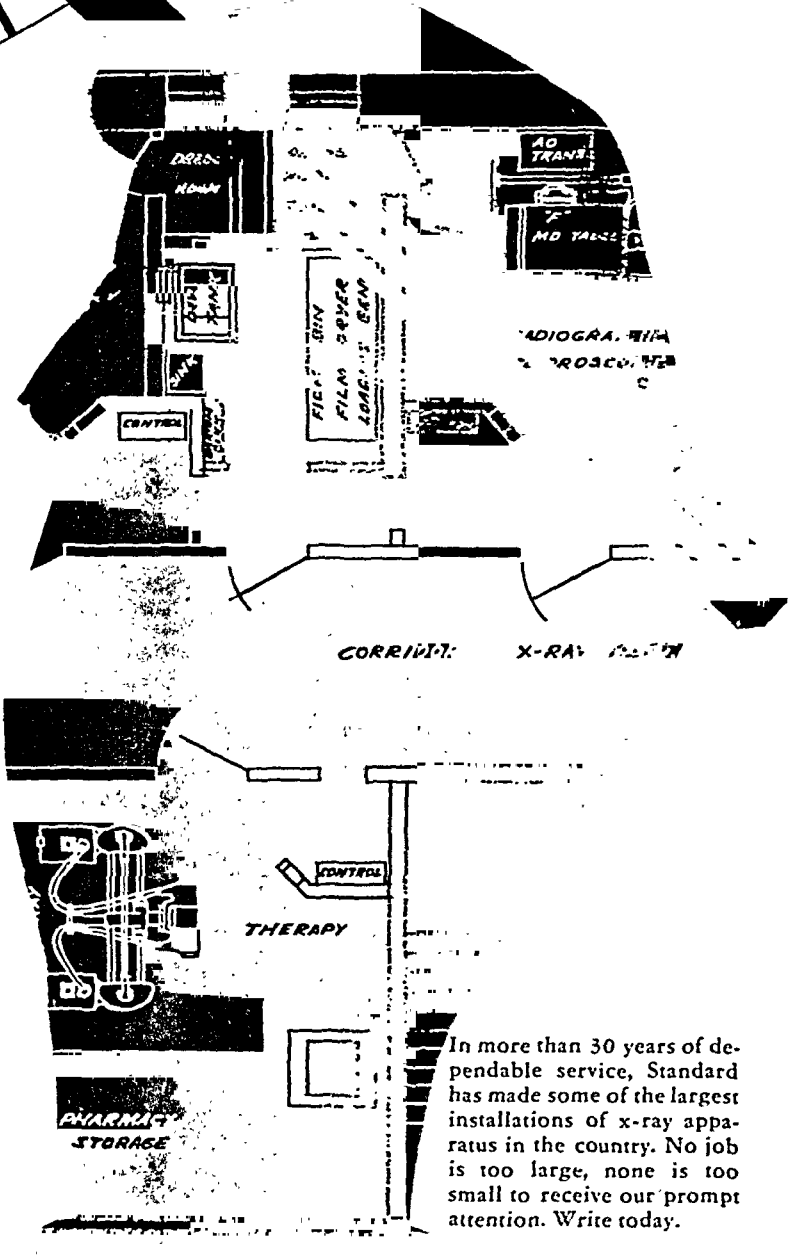
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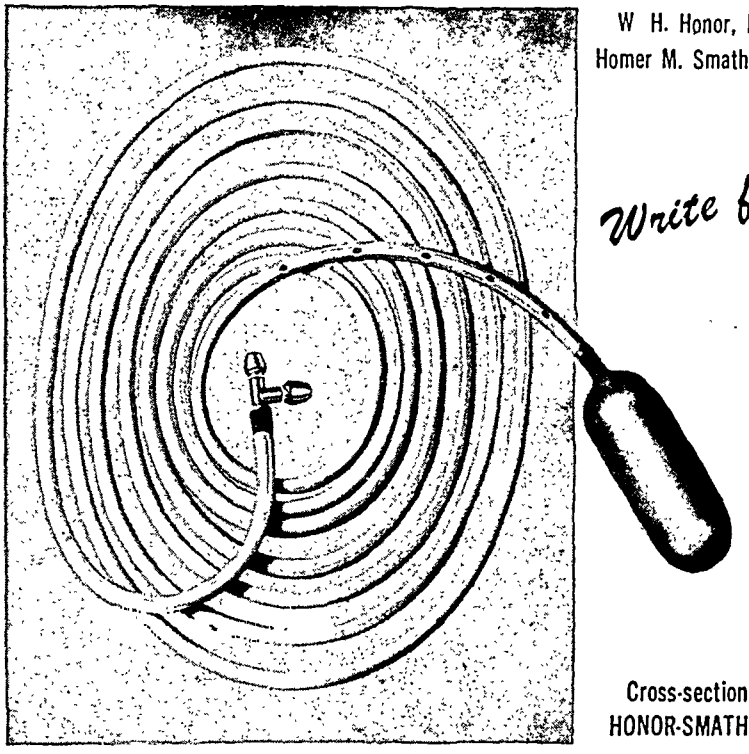
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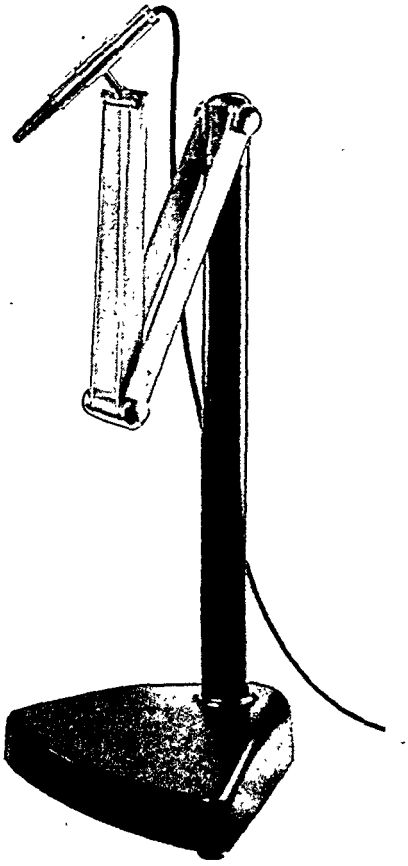
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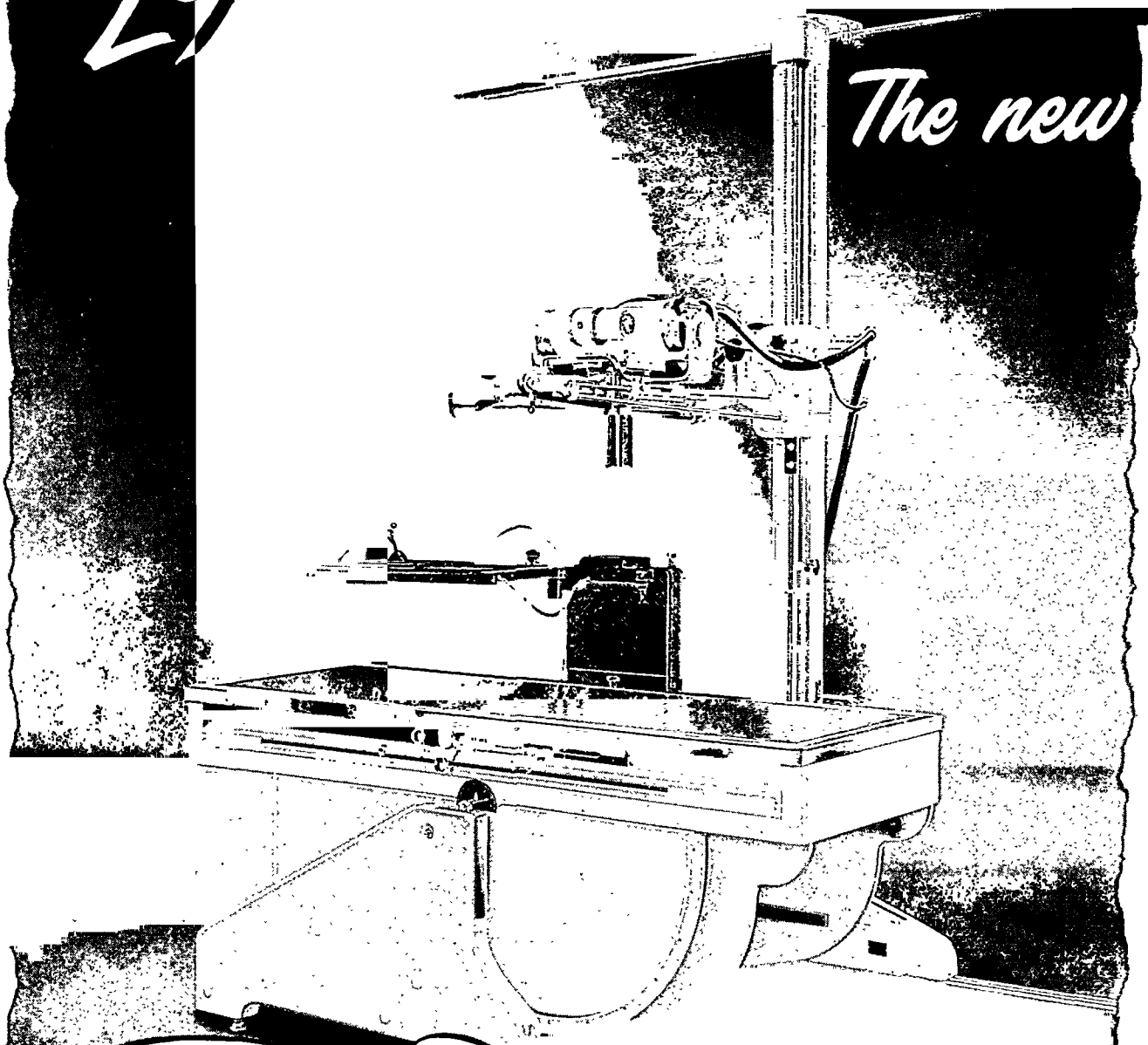
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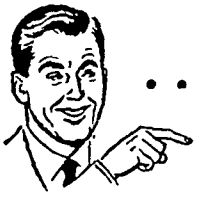
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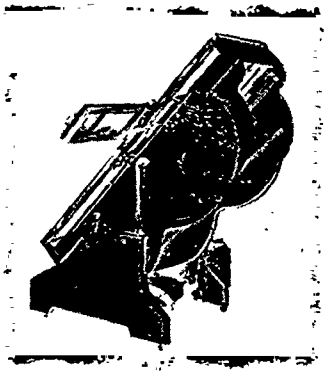
...EASY OPERATION...GREATER SAFETY...

KELLEY-KOETT "C-Supertilt" Table

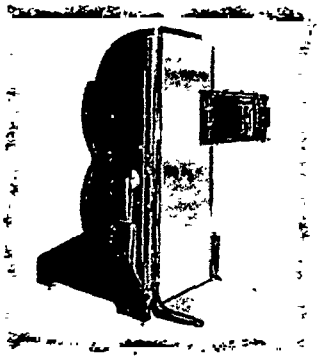


...WITH 45° TRUE TRENDELENBURG

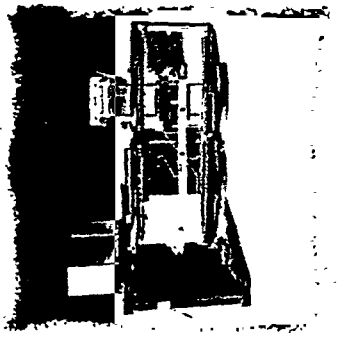
1. Three models: Radiographic & Fluoroscopic, Radiographic only, Fluoroscopic only.
2. The Only table offering 45° Trendelenburg.
3. Table top pivoted at approximately dead center; counterbalance weights are eliminated
4. Table is unusually rigid.
5. Large, easy to read table top angulation indicator.
6. High tension cable can be brought out at side or head end.
7. Improved compression devices.
8. Motor drives table top from horizontal to 55° in 12 seconds.
9. Safety switch keeps table from tilting unless fluoroscopic screen is locked.
10. Double sets of limit switches control table travel.
11. Motor housing serves as observation platform.
12. Table is driven from both sides by double gear segment.
13. 135° of angulation . . . from 45° Trendelenburg through horizontal to vertical.
14. X-Ray absorption maximum of 0.5 MM of Aluminum at 60 PKV.
15. Table is impervious to water and diagnostic solutions.
16. No holes in table top . . . attachments are made on side of table.
17. High speed Bucky, 17″ x 17″, 50 line grid, 1/10 second to 30 second timing range.
18. Bucky covers up to 66″ of table range . . . to within 3″ of foot end.
19. Reciprocating Bucky available.
20. For Fluoroscopic work, uses Patterson B-2 screen and Scholz four and one spot film tunnel.
21. Fluoroscopic tower is disappearing type.
22. Fluoroscopic screen or spot film device has four positive locks for every technic.
23. Uses Aeromax "15" or Dynamax "26" tubes.
24. 18″ focal spot without reduction of table angulation.
25. Interchange of tubes easily done in field.
26. Lead bronze cone and steel plate protect against scattered radiation.
27. Cross travel of fluoroscopic tube is 10″, longitudinal—42″
28. Fluoroscopic screen moves up to 66″ above floor (vertical).
29. Cables and wires arranged for freedom of movement.



135° angulation from 45° Trendelenburg through horizontal to vertical.



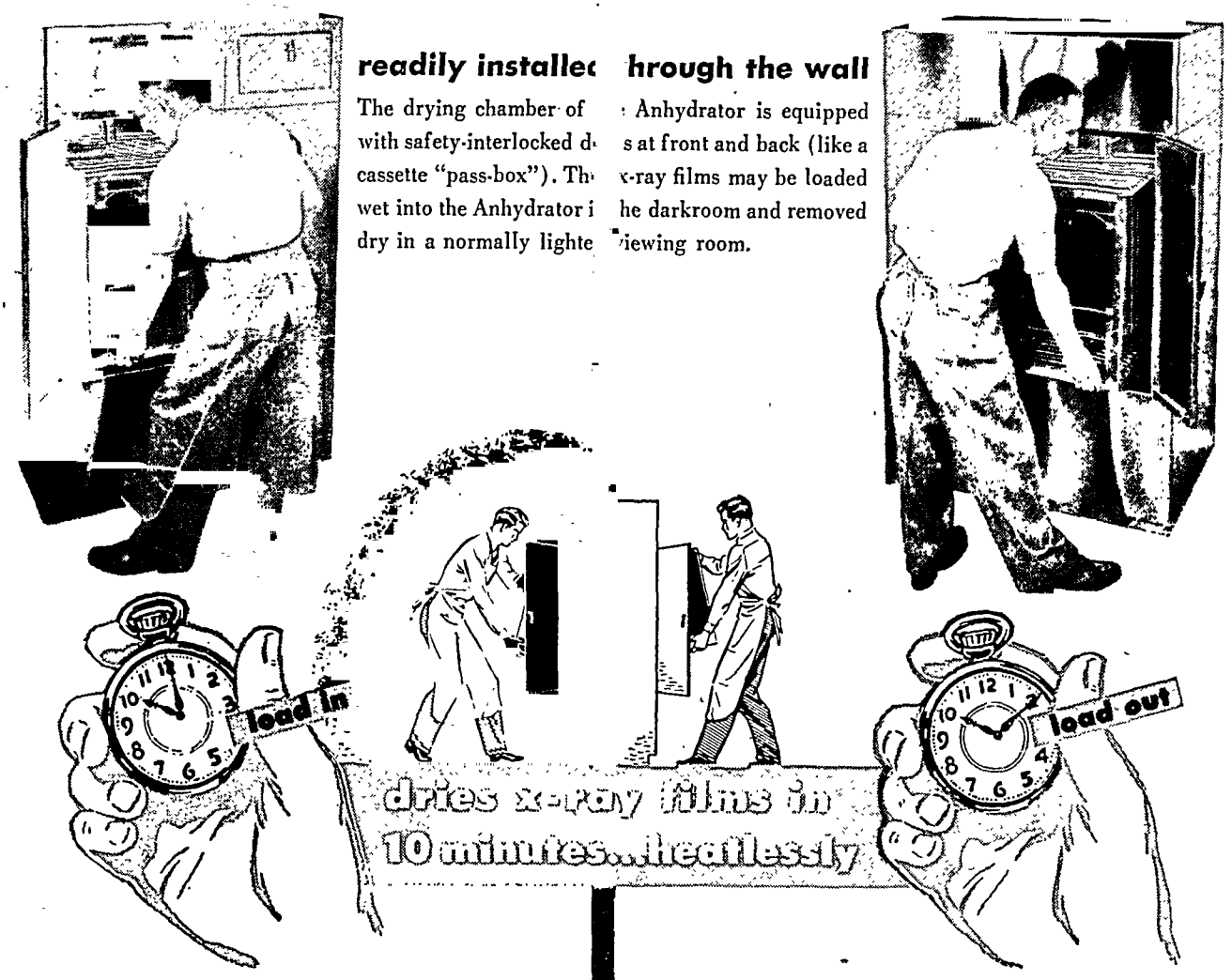
Geared head motor drive and double gear segments drive table from both sides.



Moves from horizontal to 55° in 12 seconds. Bucky travels to within 3″ of foot end.

Radiologists who have seen the "C-Supertilt" Table agree there's nothing like it. Call your Kelley-Koett representative or write for detailed information on this great new table today.

The KELLEY-KOETT Manufacturing Co.
2051 2. WEST FOURTH ST. COVINGTON, KY.



readily installed through the wall

The drying chamber of Anhydrator is equipped with safety-interlocked d s at front and back (like a cassette "pass-box"). Th x-ray films may be loaded wet into the Anhydrator i he darkroom and removed dry in a normally lighte iewing room.

films are dried without heat

Films are dried by exposure to a rapid current of dry air. The moisture absorbed by the passing air is extracted *without* heat by a unique anhydrating (water-extracting) agent in a separate chamber and then recirculated to the drying compartment.

at a surface temperature of 68°

The surface temperature of the x-ray films in the Anhydrator will not rise above 70° F. during drying, so that the same ideal temperature maintained through temperature-controlled processing steps is preserved throughout the drying period.

regardless of external humidity or temperature

Even if the darkroom temperature is 90° or over, the same even 68° F. film surface temperature inside the drying chamber is maintained. Anhydrator drying performance is uniform winter or summer, unaffected by climatic conditions.

in a dust-free closed-system atmosphere

During operation, no room air enters the Anhydrator; nor does moisture laden air require exhausting. The system is completely self-contained, the same air being used to absorb the moisture from the films, after which it is dried and recirculated. Anhydrator-dried films are delivered dust-free, sparkling clean.

does not affect film quality or density

Because of ideal film-surface temperature during drying, the gelatin will not swell or crack due to high-temperature "cooking." Fine detail and delicate differences in radiographic film densities are fully retained by drying without heat. Film reticulation cannot result.

no film contact during drying: no abrasion

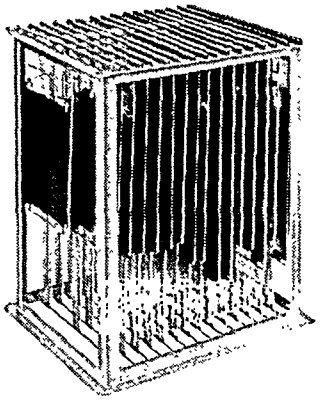
Films cannot touch each other in the special stainless steel racks. There is ample space between films for free air passage, and spacer bands prevent accidental sticking.

no ducts to build . . . simply plug it in

The Anhydrator is completely self contained. Simply place it in the most convenient location (through the wall, if desired) and plug it into any standard 110 volt AC receptacle (or DC, if specified). No architectural remodeling is required: no exhaust ducts need be provided.

automatic overnight reactivation

At the close of the working day, the electric timer of the Anhydrator will automatically flip a switch, and the anhydrating agent will be regenerated overnight. This same automatic control will halt reactivation in ample time to have the Anhydrator ready for service in the morning. This regeneration will take place at the pre-selected times every twenty-four hours.



The Anhydrator Film Rack

The Anhydrator film rack accommodates sixteen x-ray films of any size or assortment (up to 14" x 17") carried in standard x-ray film hangers. The rack is strongly and rigidly constructed of welded stainless steel channels. There is ample space for free air passage between films, which are further separated in the rack by taut spacer-bands of water-impervious plastic braid to which films cannot stick. The drying chamber takes one rack per load. The chamber is equipped with a reciprocal locking device which prevents opening the doors on one side while the doors on the other side are open. The lock also incorporates a safety switch which turns off the fan while any door is open and turns it on again when doors are closed.

overnight regeneration

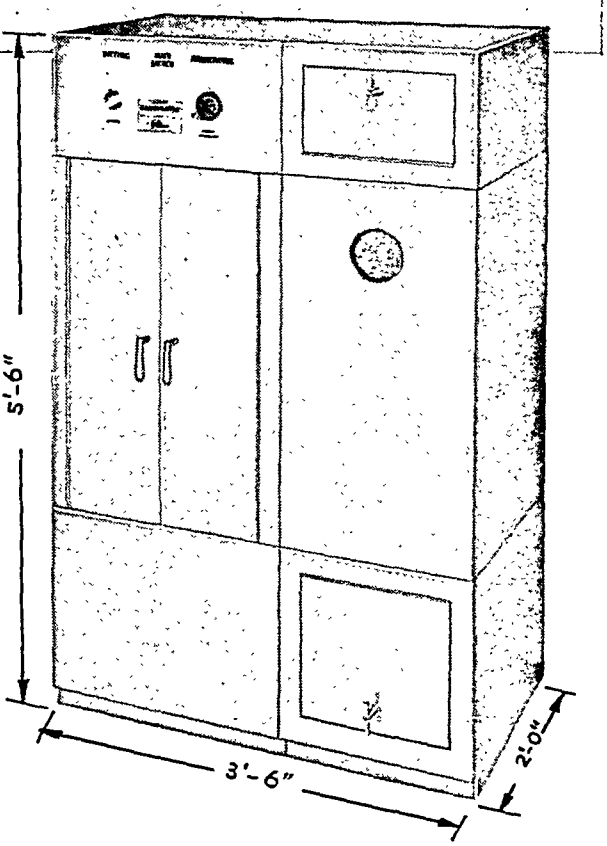
The length of regeneration time and the period chosen will depend on the quantity of films to be dried in a twenty-four hour period. The safest and most convenient cycle would be to start regeneration at the close of the working day and continue until one hour before the next day's drying is started. If smaller quantities of films are dried, this period of regeneration may be reduced (or postponed till dessicant is saturated . . . see below). It is preferred that the reactivating period be selected so that it ends approximately one hour before operations begin. Once the cycle is set on the time clock, it will automatically repeat every twenty-four hours.

saturation signal

In situations where the work load per day is not large enough to exhaust the drying capacity of the Anhydrator, regeneration is required only when the color of the dessicant (seen through the viewing port) changes gradually to red, to indicate ultimate saturation. This color change depends directly on the total square inch area of the films dried so that if traffic is light over a given period, it may not be necessary to regenerate for several days.

Drying capacity before regeneration is required

Film Size	*Total (approx.)*
5"x7"	3250
8"x10"	1425
10"x12"	950
11"x14"	750
14"x17"	500



FISHER anhydrator

Trade Mark Reg. U. S. Pat. Off.

manufactured for and distributed by Picker

easily operated

These are the simple Anhydrator controls:

SIGNAL TIMER controls drying periods. Set it for drying time when films are put in drying chamber. At end of drying, timer automatically turns off Anhydrator and buzzer sounds.

MASTER SWITCH controls entire Anhydrator and all components.

REGENERATION TIMER which automatically starts and stops regeneration; it operates automatically in any selected period each twenty-four hours.

PILOT LIGHTS marked "drying" and "regeneration" respectively, indicate phase of operation.

PICKER X-RAY CORPORATION
300 FOURTH AVE., NEW YORK 10, N.Y.

☐ Please send descriptive bulletin on Anhydrator.

We process daily (_____) films of various sizes.
(quantity)

☐ Please have your representative call.

NAME_____

ADDRESS_____

CITY_____ STATE_____

X-RAY supplies when you want them

X-ray films? Storage chests? Cassettes? Barium Sulfate? When you want them in a hurry, order the G-E X-Ray way! A telephone call or wire, a letter or a card, to one of the 57 G-E X-Ray branches and warehouses gets *immediate* attention. Shipments are made promptly and accurately. And with every order comes the satisfaction that G-E service always brings. Look at these items. Pick the ones you need NOW. *G-E will do the rest.*



G-E SUPERMIX CHEMICALS

Superior quality radiographs in 4 minutes—at less cost per film—with Supermix. Refresher keeps developer strength constant.

To make	*1 gal.*	*3 gals.*	*5 gals.*
Developer	$1.15	$2.75	$4.50
Refresher	1.15	—	5.25
Fixer	1.15	2.70	4.25

G-E BARIUM DIAGNOSTIC OPAQUES

Because barium compounds spoil easily, G-E X-Ray packs them in handy one-pound cans. Rigidly tested for purity and texture.

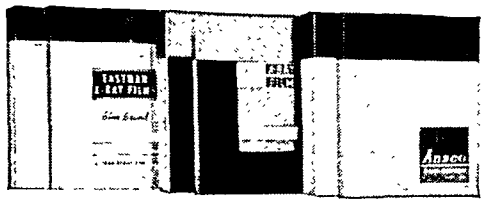
G-E Barium Sulfate	five 1-lb. cans	$1.60
G-E Bari-O-Meal (chocolate or vanilla flavor)	five 1-lb. cans	2.10
G-E Neo Bari-O-Meal	five 1-lb. cans	2.10

Check your G-E supplies catalog for quantity prices



X-RAY FILMS

The fresher the films, the better the results. And G. E., by virtue of its fast turnover and rigid stock control, can rush you films of any type or size in the three leading brands (Ansco, DuPont, Eastman). Order through your nearest G-E X-Ray office. See catalog for prices.





DARK-ADAPTOR MONOGOGGLES

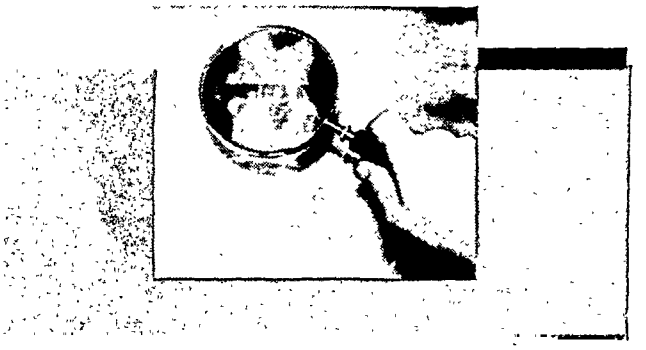
Developed by the Army for night-flying pilots. Wear them prior to entering the fluoroscopic room. Complete eye-adaptation within 30 minutes without hindering normal activity. Fit over spectacles.

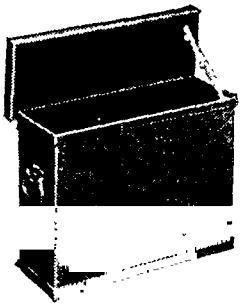
Cat. No. E3003G—G-E X-Ray Dark-Adaptor Monogoggles $3.00

READING GLASS

Guard against missing small, but important, details on the negative with this fine 3½ inch diameter magnifying lens.

Cat. No. E8016B Reading Glass $3.00

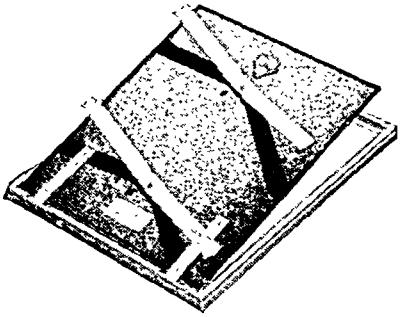




LEAD-LINED ALL METAL FILM CHEST

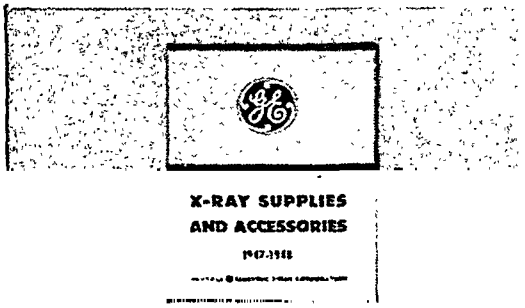
This chest is completely x-ray proof. It provides safe storage for eight dozen 14 x 17 inch films, or eight 14 x 17 inch cassettes. Sponge-rubber innersole absorbs shocks.

Cat. No. E3006A—G-E X-Ray All Metal Film Chest, lead-lined $76.00



STELE-WELD RAYSPEED CASSETTE

Stele-Weld Cassette frames are welded steel. Stele-Weld hinging is kind to intensifying screens. And the Rayspeed front permits lower energies—provides better definition in soft tissue work. Full range of sizes, with or without screens. See catalog for prices.



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It's the x-ray user's bible—a 72-page catalog listing everything you could ever need in the way of x-ray supplies. More than 750 items, 200 photographs.

G-E X-Ray Supplies and Accessories Catalog mailed without charge

These are just a handful of the hundreds of items your nearest General Electric X-Ray office can speed to you. Remember, *for x-ray satisfaction, buy the G-E X-Ray way!* General Electric X-Ray Corporation, Dept. L-41, 4855 McGeoch Ave., Milwaukee 14, Wis.

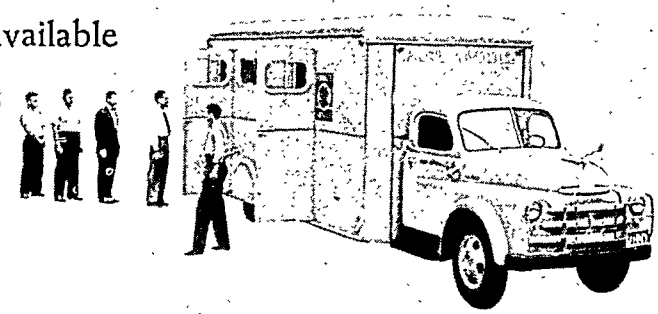
GENERAL ELECTRIC X-RAY

General Electric X-Ray Corporation manufactures and distributes x-ray and electromedical supplies and accessories; x-ray apparatus for medical, dental and industrial use; electromedical apparatus.

POWERS is the leader

In CHEST X-RAY SERVICE

By all odds Powers has the most to offer—the largest facilities—the longest experience—the greatest total production of X-rays. No assignment is too big because Powers has by far the largest number of X-ray teams available anywhere. No job is too special, or too remote, because Powers has introduced the Mobile Trailer Unit equipped with its own source of electric current.

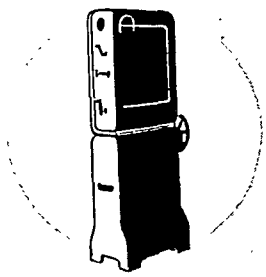


POWERS OFFERS WHICHEVER MEDIUM SUITS YOUR PROBLEM

70MM Photofluorographs • ***14" x 17" Paper Radiographs***

Avoid Technical Problems
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By Using Powers

ADDITIONAL FEATURES OF POWERS COMPLETE SERVICE

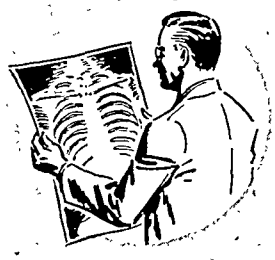


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Double the output of present equipment simply by renting, at low fee, the Powers Magazine Cassette. One loading, easy as a camera, produces 50 full size 14" x 17" paper radiographs.

POWERS X-RAY PAPER

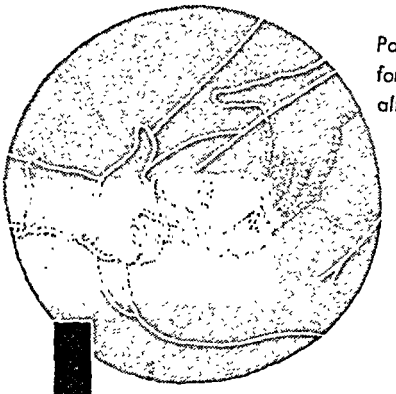
Available in all standard sheet sizes, Powers X-Ray Paper cuts cost far below other media, yet provides radiographs of high diagnostic quality with excellent contrast and definition.



With such complete facilities, Powers is in position to offer impartial counsel on your X-ray problem. Your inquiry is invited.

X-RAY

POWERS X-RAY



Palpation for structural alterations

Lipiodol*

completes the diagnostic picture...

Visualization with Lipiodol of the uterine cavity and tubes furnishes the essential evidence required for diagnostic accuracy. Tubal patency or blockage, the presence of uterine malformations, or tumors are but a few of the necessary diagnostic features revealed by Lipiodolography. Function as well as structure can be determined with greater precision thus completing the diagnostic picture. In addition its usefulness in delineation of the accessory nasal sinuses, as well as in bronchography, sialography and myelography, further establishes Lipiodol as an important adjunct in diagnostic roentgenography.

Hystero-salpingography with Lipiodol reveals both structural and functional impairment.



A contrast medium of choice because:

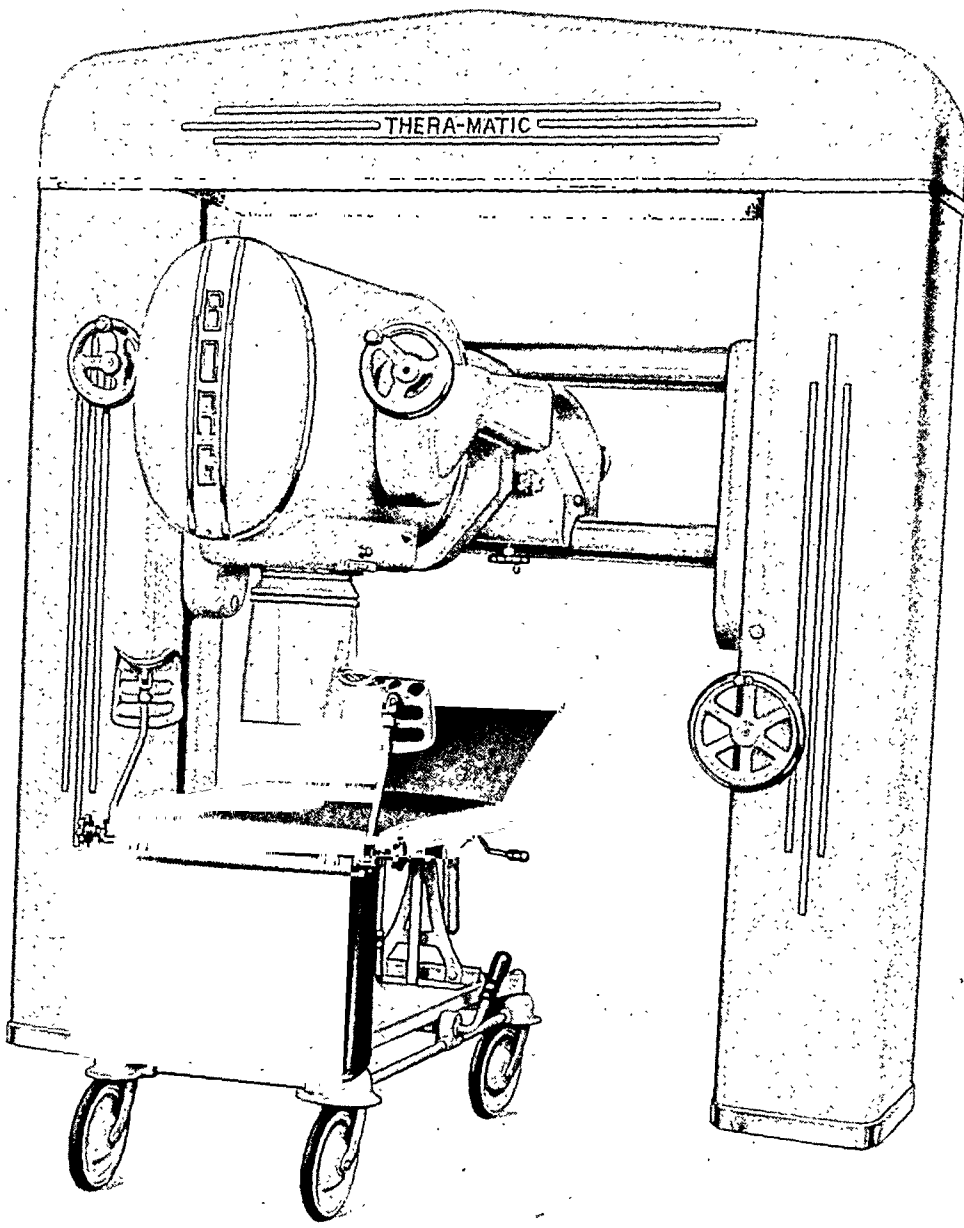
1. Firmly-bound 40% iodine in poppyseed oil insures uniform radiopacity.
2. Its viscosity produces clear delineation without excessive "pooling".
3. Exclusive formulation does not involve use of chlorine or its derivatives.
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Lipiodol is the registered trade-mark for the original product created by Lafay. This product alone can bear the name Lipiodol. Made in the U. S. A. Available in a variety of ampoule sizes and 20 cc. multiple dose vials. E. Fougera & Co., Inc., New York, N. Y. Canadian Distributors: Vinant, Ltd., Montreal, Canada.

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THE GEORGE W. BORG CORPORATION



Thera-matic Constant Potential, Full Wave Rectified, Deep Therapy X-Ray Unit

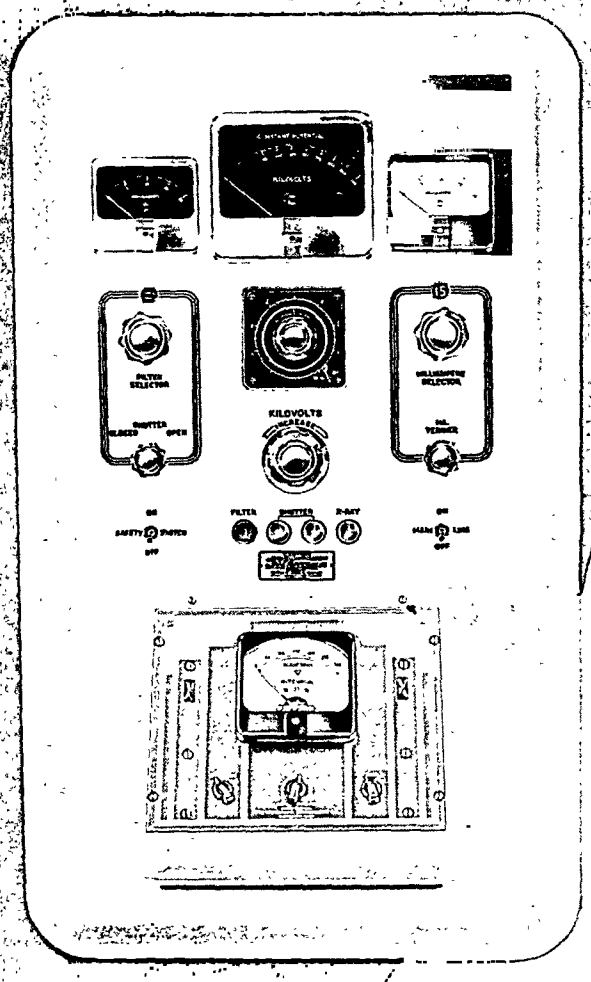
- **SELF-CONTAINED**
- **250 K.V.—15 MA. CAPACITY**
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40% to 50% More Roentgen Units Than Other 250 K.V.—15 Ma. Capacity Non-Constant Potential Equipment

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WALL CONTROL



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- Extremely flexible Gantry type stand
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- Large calibrated kilovolt meter
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- Can be had with

WALL CONTROL

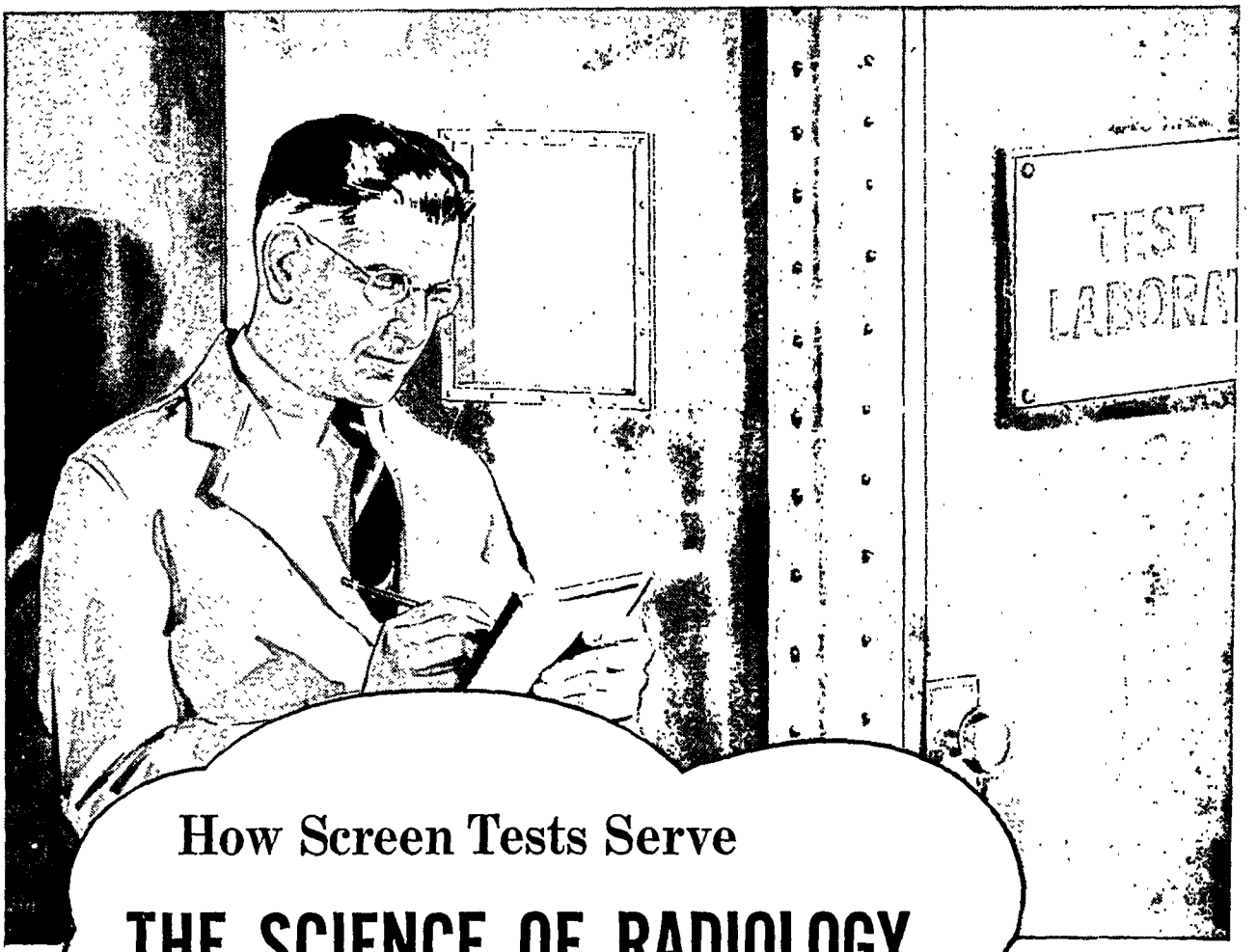
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At 250 K.V.—15 MA.—50 CM. Distance		
1.0 AL. + .5 CU.	— 100.0 R/MIN.	H.V.L. 1.75
1.0 AL. + 1.0 CU.	— 77.5 R/MIN.	H.V.L. 2.85
1.0 AL. + 2.0 CU.	— 54.5 R/MIN.	H.V.L. 2.95
1.0 AL. + 3.0 CU.	— 42.0 R/MIN.	H.V.L. 3.50

The George W. Borg Corporation

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How Screen Tests Serve

THE SCIENCE OF RADIOLOGY

New Patterson plant contains improved screen testing facilities.

THE production of "Patterson" Intensifying and Fluoroscopic Screens is an intricate and highly scientific procedure rigidly controlled by laboratory technicians.

To insure the quality and uniformity for which these screens are well known, scientific tests are made continuously throughout the manufacturing process. No minute detail of the operation is overlooked and even the pre-tested luminescent chemicals used are first carefully analyzed to make certain that they measure up to exacting standards of the science of radiology.

In addition, every "Patterson" Screen receives a final examination . . . a check-up for uniformity of speed . . . for ability to render detail and contrast . . . and for mechanical perfection. "Patterson" Screens *must* be entirely free from dirt, blemishes, marks of any kind, or extraneous matter which might obscure diagnosis. And this is true of *every* "Patterson" Screen ever made.

Superior radiographs require, first of all, superior skill. But even the highest skills require the best of "tools." A fine radiograph cannot be produced with a screen in poor condition, nor with a cassette which does not give perfect contact. That is why it is important to specify "Patterson" when ordering new screens or replacing screens that have become damaged, worn or stained. Your dealer has a complete stock.

E. I. du Pont de Nemours & Co. (Inc.)
Patterson Screen Division
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BETTER THINGS FOR BETTER LIVING
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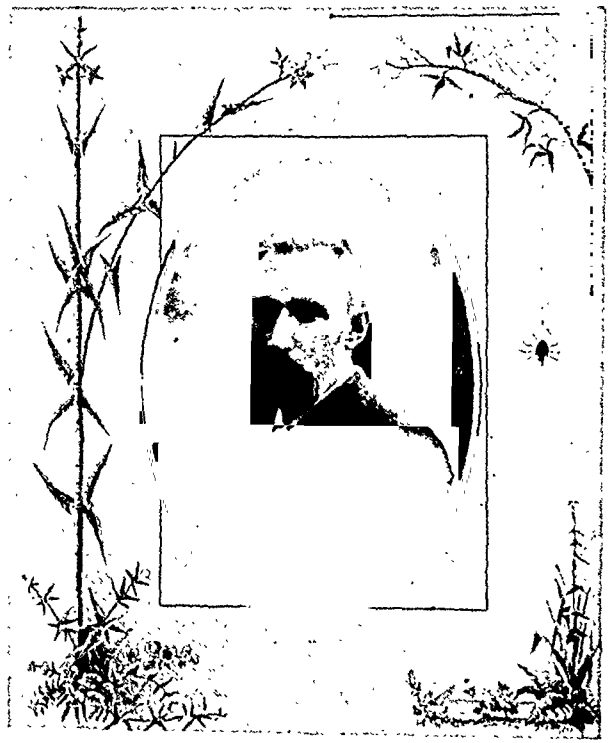
"Patterson" Screens

The Standard of Screen Quality

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Marie Curie



Pierre Curie

THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

VOL. 60 DECEMBER, 1948 No. 6

FIFTY YEARS OF RADIUM*

By EDITH H. QUIMBY, Sc.D.

College of Physicians and Surgeons, Columbia University

NEW YORK, NEW YORK

RADIUM was discovered fifty years ago. In the succeeding half century it has played an important triple role in medicine, science, and industry. It would have been difficult or impossible to forsee the significance of the discovery; it was regarded at the time mainly as a scientific curiosity. Nobody then had the vision to anticipate that it would open up whole new fields of medical and scientific research,—to say nothing of international relations.

We are today commemorating the discovery of radium; in so doing we pay tribute to the discoverers, Marie and Pierre Curie, and we may well recall a little of their story. The production of x-rays had been announced by Roentgen at the end of 1895, and immediately physicists everywhere had started to duplicate and extend his experiments. Early x-ray tubes all fluoresced brilliantly, and it was natural to associate this fluorescence with the new rays. Various workers suggested the possibility that naturally fluorescent minerals might also give off invisible penetrating radiations, and a few sporadic efforts were made to find such a phenomenon. Becquerel, in Paris, undertook a systematic investigation of the problem, testing a large variety of minerals and compounds. He discovered that compounds of uranium which were fluorescent did actually emit invisible radiations, which darkened a photographic plate. Furthermore, to his surprise, he found that it was not at all necessary for the material to be fluorescing or phosphorescing in order for it to produce this effect. Becquerel announced this discovery in the spring of 1896 (only a few months after Roentgen's first paper) and went on studying the phenomenon during that year. He observed that, in addition to their photographic effect, these rays could discharge an electroscope. He also found that all compounds of uranium emitted them, that is, the radiation was a property of uranium, regardless of its chemical combination.

It was at this point that Mme. Curie entered the picture. A shy, but talented and studious Polish girl, Marie Sklodowska, had grown up in Warsaw, while it was under oppressive Russian domination. All Polish national feeling was strongly suppressed and Polish schools were severely limited. Her elementary and secondary education

* An Address delivered at the Annual Banquet at the Thirtieth Annual Meeting of the American Radium Society, Chicago, Ill., June 20–22, 1948.

was acquired partly in private and partly in government schools. Afterward she worked as a governess, meantime striving to carry her education to the point where she might to go Paris and study at the Sorbonne. This she finally achieved in 1891, at the age of twenty-four. Within three years she had graduated as a licencié in physics and mathematics, and was ready to begin work for her doctorate. About that time she met Pierre Curie; they were married in 1895. During the next two years they worked together in his laboratory, so that she acquired facility in experimental research, while seeking a suitable problem for her doctor's thesis. She became interested in Becquerel's work, and decided to study the radiations which he had discovered. It was of interest to see whether any substances besides uranium emitted them, and it was desirable to make quantitative measurements of their intensity. She quickly demonstrated that the amount of activity in a uranium compound was exactly proportional to the amount of uranium there; in other words, it was a definite property of the uranium atom. To see whether other atoms also gave off radiations, she studied all the elements then known, and found them emitted only by uranium and thorium. She coined the word *radioactivity* to describe or define the phenomenon.

During the course of her research she examined not only elements and compounds, but also a number of natural ores or minerals. To her great surprise, she found that certain of these, containing uranium, were much more active than could be accounted for by their content of this metal. She was obliged to believe that these ores must contain very small quantities of some element, hitherto unknown, which was much more strongly radioactive than uranium itself. She had, as she says, a passionate desire to verify this hypothesis as rapidly as possible. And her husband, also keenly interested, abandoned his own research (as he thought for the time being) to join with her in the investigation.

They chose to work with pitchblende, a uranium ore about four times as radioactive as the element itself, and whose composition was quite well known. They used standard chemical procedures,—pulverization, solution, precipitation, fractional crystallization—but at every step they tested the radioactivity of each portion. They soon recognized that the new substance was concentrating in a regular way —and then presently they discovered that they had not one, but two new radioactive elements. One, staying with bismuth in all the reactions, was identified first, it was announced in July 1898, and named polonium, in honor of Mme. Curie's native country. The other, associated with barium, was separated later; it was announced that December with the name of radium, to indicate its very intense activity.

These first separations involved only minute quantities of the new elements, in order to find out anything about them beyond their radioactivity, it was necessary to isolate measureable amounts. This meant subjecting many kilograms of the ore to careful chemical treatment, since its radium content was so minute—not more than one part in several million.

They had no money, no suitable laboratory, no personal help,—as she says in her autobiographical notes "it was like creating something out of nothing." They wanted to isolate the radium from a considerable amount of pitchblende, but they could not even afford to buy the ore. However, they knew from their experiments that in the commercial treatment of pitchblende in the Bohemian mines, radium must have been left in the residues. Fortunately these residues had not been scattered, but had been piled in a heap outside the plant. They were there quite valueless, and the Austrian government gave them some, and later sold them several tons at a low price. From this material was prepared all the radium Mme. Curie had in her laboratory for many years.

They were allowed to carry on their work in an old shed with a leaky glass roof, cold

in winter, hot in summer; they had only the most primitive of laboratory equipment. But there they spent their entire time for the next two years, occupied both with chemical research and with gradually obtaining appreciable amounts of radioactive material and studying the radiations. After that period of joint work, they divided their efforts. Mme. Curie continued with chemical experiments leading to the preparation of pure radium salts; her husband went on studying the properties of radium.

During this time they were leading a quiet but happy family life. Their first daughter, Irene (destined to become a famous scientist in her own right) had been born in 1897, in 1904 came the second one, Eve (who has had a distinguished musical and literary career). In 1900 both husband and wife received good academic appointments, so that their financial strain was eased and they were able to have better laboratory facilities.

In 1903 the Curies and Becquerel jointly were awarded the Nobel prize for physics. Other prizes and awards followed and it looked as though a brilliant future stretched before them. Then in 1906 Pierre was suddenly killed by being struck by a truck. This was a catastrophe, both to the family and to the scientific world. At first Mme. Curie thought she could not go on, but of course, as a true scientist, she was bound to. Presently she was offered her husband's professorship at the Sorbonne, and there she carried on her work.

In 1907 she prepared a small quantity of very pure radium chloride, with which she made an accurate determination of the atomic weight of radium. In 1910 she isolated the metal. This is a delicate operation, and one attended with danger of loss of radium. Since the substance is never used in the metallic state, it is not a procedure to be frequently repeated, and actually it has since been done seldom if ever. In 1911, at the request of an international commission, she undertook to prepare an accurate standard of a carefully weighed quantity of pure radium salt. This is in the International Bureau of Weights and Measures at Sèvres, near Paris, and all other standards in all countries have been established by comparison with this. In that same year she was awarded a second Nobel prize, this time alone,—the only person to have been thus honored.

When war came in 1914, she plunged into the organization of radiologic services in the military hospitals. After helping to equip the numerous new institutions that were established all over France, she conceived and put into action a radiologic field car, containing a complete radiographic unit. It was such a success that twenty of them were finally put into service at the front. During this time she made many trips to various army zones, and was unsparing of herself in the actual labor of installing equipment and training personnel.

After the war she devoted herself to the newly established Radium Institute, where both laboratory and medical work were carried out with radium. In 1921 the women of America presented her with a gram of radium for her own scientific research. She came to the United States to receive it, and incidentally many scientific and academic honors. Though always tired and often ill, her years of hard labor and her considerable exposure to radium having left their mark, she continued to direct her laboratory to the time of her death in 1934.

The Curies never accepted any material profit as the result of their discoveries. They took out no patents nor did they sell the radium they extracted. They were often in straitened financial circumstances, even when medals and decorations were being awarded to them. Had they so chosen they could doubtless have capitalized on their achievements, after the discovery of radium had become known, and have consequently lived in greater ease. But theirs was the true scientific spirit. All their discoveries and methods were freely published and available to anyone. All their work was for the unselfish purpose of in-

creasing the sum total of human knowledge,—one wonders what they would have thought if they could have seen where that knowledge would lead.

It would have been impossible, fifty years ago, to predict, or even to imagine the consequences of their work. The discovery of radioactive substances has led to astonishing results in medicine, in physics, chemistry, biology, in business, and in international relations.

The medical use of radium developed from a minor accident. Becquerel carried a glass tube containing radium salt in his vest pocket, and was surprised to find a sore, like a burn, appear on his abdomen. Pierre Curie deliberately produced a similar burn on his arm; this demonstration of the biological effect of the radiation led to animal experiments and to the suggestion of its use in treatment of certain skin diseases. The first radium for medical use was loaned by the Curies to Danlos, at the St. Louis Hospital in Paris. After about three years trial, he published reports on its usefulness in a limited field. In 1906 Wickham and Degrais established in Paris a center for the study of radium therapy, under the name of the Biological Laboratory of Radium, with Dominici in charge of the clinical work. Here the uses of filtration and of cross-fire were promptly discovered and other improvements made in technic.

In England the Radium Institute of London was formed about the same time, and in America various doctors obtained radium for use in therapy. Dr. Robert Abbe of New York was apparently the first person to implant radium directly into a tumor, in 1905 but intracavitary use in gynecology preceded this in France.

Mme. Curie had discovered that radium gave off a radioactive gas, which she called Emanation—it is now called radon. This has all the biological effects of radium itself, and it began to be employed in therapy, both in France and in America. The precious radium—and at that time it was extremely valuable,—could be kept in a safe, with no danger of loss, theft, or breakage, and the gas regularly drawn off. Such installations were made at Memorial Hospital in New York, the Howard Kelly Hospital in Baltimore, the Huntington Hospital in Boston, and eventually a considerable number of others. At the Memorial Hospital, Janeway and Failla developed methods of implanting tubes of radon directly into tumors, first bare glass ones, and later those of gold, which filtered out the less penetrating rays responsible for most of the local necrosis formed around the glass ones. The advantage of this type of therapy, was that, since the radon lost its activity gradually over a period of a month, the little containers, or "seeds" did not need to be removed, as had to be done with needles actually containing radium. This simplified the necessary surgical technic.

However, since the great decrease in the price of radium, and the manufacture of a variety of small removable radium needles, some of the advantages of permanent implants are not so great. With development of various special types of x-ray therapy, the use of radium or radon in superficial lesions has become largely outmoded. The result has been that most of the radon plants in this country have been dismantled, the radium put into permanent containers, and commercial companies depended upon for the supply of radon when it is desired.

Because the gamma rays of radium are much more penetrating than the x-rays which are usually available for therapy, they offer a means for treating deep-seated tumors. As production of radium became considerable and its price somewhat reduced, several institutions acquired relatively large amounts which they used in large "packs" or "bombs," the radium being at several centimeters distance from the skin. This "Telecurie Therapy" found enthusiastic advocates in France, Belgium, Sweden, England, and to a less extent, in America. Treatments must be very long, and even with large amounts of radium, depth doses are not very good because the radium-skin distances used can be only a few centimeters. With the development of

x-ray machines operating at one or several million volts, the advantages of telecurie therapy cease to exist and most of the large units in this country have been broken up.

But radium still possesses its unique place in intracavitary and interstitial therapy. Here its advantages are great and unquestioned. It may be superseded by some of the artificial radioactive elements, but that is not evident at present.

No account of the history of radium would be complete without some details as to its commercial production. The first preparations of nearly pure radium salt were put on the market by Dr. Giesel, of the Chininfabrik Braunschweig; he first sold radium bromide at one English pound per milligram. Later it went to 12 times this, but this firm never really made a business of radium supply. The idea of a radium factory was first conceived by a Frenchman, Armet de Lisle, and in cooperation with the Curies he actually started one, in 1902, which supplied the early French demands. He also founded, in 1906, a laboratory for clinical study, providing it with radium, and he subsidized the first special publication devoted to radium.

Other extraction plants developed in Europe. The source of their ore was at first the Bohemian pitchblende, of which the Austrian government had made a monopoly. Then radium was discovered in a Colorado ore called carnotite and for a time this ore was shipped to Europe.

In 1911 the Standard Chemical Company was formed by Mr. Joseph Flannery of Pittsburgh, to separate radium from carnotite in the United States, and their first radium was put on the market in 1913. This was a completely new industry; it was not possible to get any of the few men who had been trained in this field in Europe, so the whole procedure had to be developed from the beginning. The Colorado carnotite was a much poorer ore than pitchblende. Whereas the latter had a gram of radium in 4 or 5 tons, in the former, 400 or 500 tons were necessary—and each of these 400 or 500 had to be hand picked out of a much larger mass of dirt, and rock. This was done in the field. The crude ore was carried out by burros to a central concentration plant where it was pulverized, sacked, and sent to the Pittsburgh plant for refinement. In reducing and purifying one gram of radium from 500 tons of ore, it was necessary to use 10,000 tons of distilled water, 1,000 tons of coal and 500 tons of chemicals. It is no wonder that this gram of radium sold for $120,000, —and it had a volume less than a thimble full.

About the same time that the Standard Chemical Company got under way, Dr. Howard Kelly, of Baltimore, brought some radium from Europe. He was very much pleased with his clinical results, and became interested in producing the material in America. Accordingly, he joined forces with Dr. James Douglas of New York, a distinguished mining engineer, and the U.S. Bureau of Mines, and formed the National Radium Institute to extract radium from carnotite. Dr. Kelly and Dr. Douglas provided the capital, and the Bureau of Mines developed the processes and supervised the work. The agreement lasted from 1914 to 1917, during which time about 8.5 gm. of radium were extracted, most of which was divided between the Kelly Hospital in Baltimore, and the Memorial Hospital in New York. Meantime several other commercial companies came into the field. Some were short lived, but two, the Radium Company of Colorado, and the United States Radium Corporation, as well as the Standard Chemical Company, were stable as long as American ore was the world's chief source of radium, namely until 1923.

Much richer ores had been found in the Belgian Congo as early as 1913, but during the war nothing was done about developing them. However, after 1920, the Union Minière du Haut Katanga, and its subsidiary, the Radium Belge, began to produce radium. This ore, mined in the Congo, was packed in sacks and carried

overland 1,600 miles to the seacoast and there shipped to Belgium for purification. With ores forty times as rich as carnotite and with cheap labor, the cost dropped to $70,000 a gram. The radium industry in America could not compete and was practically wiped out over night; the American concerns arranged to market the Belgian product.

This had a monopoly for a number of years, and maintained its price around $70,000 a gram. Then about 1930, very rich radium ores were found in the Great Bear region of Northern Canada.

It appears that large uranium finds are in remote parts of the earth,—first the high ranges of the Rocky Mountains, then the tropic wilderness of central Africa, and finally the frozen north. And it is literally frozen for a considerable part of the year. The ore is partially reduced at the mines, and the concentrates flown out by plane for the final operations. The Canadian Radium and Uranium Corporation, was formed to exploit this material. Their competition brought the price down to about $35,000 a gram and it has remained in that neighborhood. Canadian and Belgian radium now supply the world's market. American companies have arrangements to sell their products, but Colorado ore is no longer used for radium production,—it is now under the control of the Atomic Energy Commission.

Developments in physics and chemistry, as the result of the discovery of radium, have proceeded at a constantly accelerating pace. From the first discovery, Pierre Curie was occupied with studying the phenomena connected with radioactivity, and trying to explain them. Debierne, Danne, Laborde, and others were associated with him in some of these investigations. One of their most striking discoveries was the spontaneous production of heat by radium. With no alteration in appearance, a radioactive salt produces each hour sufficient heat to melt its own weight in ice.

This and other phenomena attracted the attention of other physicists, and in particular of Rutherford and his associates at the Cavendish Laboratory in Cambridge. He demonstrated that not all the radiations from radioactive substances were alike; by 1899 he had identified the two types which are called alpha and beta. Villard almost immediately discovered the still more penetrating gamma rays and before the beginning of the century a number of papers had appeared concerning the characteristics and properties of the different rays.

It was promptly recognized that the alpha and beta rays consisted of matter expelled from the atoms themselves. Evidently if this were true, the atoms could not be the hard, solid, indivisible pellets they had been assumed to be. The actual demonstration as to their nature came when Rutherford set a young student, Marsden, to study the scattering of alpha particles as they traversed thin metal films. Contrary to expectation some particles were found to be scattered directly backward. Rutherford's own description of his reaction to this news is graphic. He says "It was quite the most incredible event that has ever happened to me in my life. It was almost as incredible as if you fired a 15 inch shell at a piece of tissue paper and it came back and hit you. I saw that it was impossible unless you took a system in which the greater part of the mass of the atom was concentrated in a minute nucleus." Thus arose the concept of the solar system type of atom which is accepted today. The present picture of the structure of the atom, with orderly increase in nuclear charge and in number of orbital electrons from element to element was developed from the work of many, of whom Mosley, Chadwick, and Bohr are outstanding. When this conception was accepted it became evident that in a radioactive transformation somehow a bit of the nucleus was expelled; this meant a change of the atom into an atom of another element.

The naturally radioactive elements are those with very heavy nuclei. Rutherford believed that these nuclei had a complicated

structure which was inherently unstable, and that atoms of the lighter elements, with simple stable nuclei, might be made to disrupt if some sort of projectile could be fired into them. He actually succeeded in doing this, by firing alpha particles into nitrogen nuclei, and making them eject something which was found to be a hydrogen nucleus. Thus it was proven that one of the constituents of nitrogen nuclei was this hydrogen nucleus, a little particle, of mass one on the atomic scale and having a single positive electric charge. Other elements were promptly attacked by the same weapon and many of them could be broken down, emitting this same hydrogen particle, to which was given the name "proton." Then a second component was found, identified by Chadwick as having the same mass as the proton, but no charge at all. This was named a "neutron." It is now believed that all atomic nuclei are built up of combinations of these two particles, while travelling around each nucleus in a series of orbits are just the right number of negative electrons to balance the positive electric charge on the nuclear protons.

Of course many physicists eagerly verified and extended the work of Rutherford and his group. Among the most enthusiastic of these were Irene Curie, the older daughter of Marie and Pierre Curie, and her husband, Frederick Joliot. As a scientific team, following the illustrious example of her parents, they have done brilliant work and have themselves received the Nobel prize for the discovery of artificial radioactivity. That is, they found that sometimes when they performed experiments bombarding certain elements with alpha particles, after the bombardment stopped, the target material continued to emit radiation for a time. This activity decreased gradually in the same manner as that from radioactive elements, in fact the target had been made truly radioactive. They announced their discovery in 1934, describing radioactive boron and aluminium. Since then, radioactive forms of every element have been made. These different kinds of atoms of the same element are called *isotopes*, they have the same number of nuclear protons and of orbital electrons but slightly different numbers of nuclear neutrons. They are of course actually the same element, isotopes are chemically inseparable.

Every radioactive disintegration results in an emission of a relatively very large amount of energy. During the years after the discovery of artificial or induced radioactivity, there was much speculation as to the possibility of the development of a chain reaction whereby one disintegration could set off another, and that another and so on, without the need of supplying any more external bombarders. Such a chain could serve as a source of energy for a heat generator, or, if it could be compact enough and fast enough, a bomb.

This was mere speculation for some years and then the chain reaction was actually found. When one isotope of uranium is bombarded with neutrons, it disintegrates and in its disintegration emits neutrons, which can enter other atoms, making them disintegrate, and so on.

This was discovered in 1939. A few scientists, in America, immediately recognized the military possibilities of the discovery, and tried to convince first the Navy, and then the Army of its value, but it was not until they made a direct appeal to President Roosevelt that actual work in that direction was started. The world knows the results.

Thus along the pathway of scientific research, which started a half century ago in a small investigation of a phenomenon which had no imaginable practical value, humanity has come to a crisis. Where it will go depends on itself. But humanity really means a lot of individuals,—rich and poor, well-fed and hungry, peaceable and quarrelsome, generous and selfish, wise and injudicious. There are true differences of opinion as to what is best for peoples and nations,—and there is demagoguery and hysteria; there are threats and violence and fear. The possible extension of this particular scientific pathway

can lead to great peacetime good,—or it can lead to most horrible war. This little talk is history, not prophecy. But it must be evident that only the working out of a just and stable peace, with the recognition of all men's rights to life with certain basic freedoms, and some firm, super-national, law-abiding order, can make a world in which atomic energy can properly be used.

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SIR STANFORD CADE, K.B.E., C.B., F.R.C.S.

JANEWAY LECTURER, 1948

THE ACHIEVEMENT OF RADIUM IN THE FIGHT AGAINST CANCER

JANEWAY LECTURE, 1948*

By SIR STANFORD CADE, K.B.E., C.B., F.R.C.S.

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LONDON, ENGLAND

WHATEVER the future holds in store in the way of treatment of cancer, be it isotopes or endocrines, chemotherapy or any form of ionizing energy, Radium will remain a landmark in the therapeutics of neoplasms and the second battle victory, Surgery being the first in point of time, on the road to the conquest of this foe of living beings.

It pleases me to think that Janeway, whose memory we honor today as an American pioneer in the clinical use of Radium, may perhaps smile benevolently on this gathering, as for the first time since the inception of this lecture in 1933, it is delivered by a non-American. My first duty is to thank the American Radium Society for the honor in offering me this year's Janeway Lectureship and it is a difficult task to express adequately my sense of gratitude to your President and Selection Committee and to convey to you my appreciation of this distinction.

If we pursue this flight of fancy and imagine what impression this, the thirteenth Janeway Memorial Lecture, might have had on the man whom it eponymously honors, it is necessary to say something about Janeway himself. He was pursued by ill health and he knew personally what it is to suffer from a neoplasm. He was trained as a surgeon and, by special individual effort, acquired the necessary knowledge of physics to use radium both safely and efficiently. He published forty-one scientific papers. In England his name is a household word amongst surgeons in connection with the operation of gastrostomy,[13] which he described in 1913 and which has stood the test of time as a sound surgical procedure. His greatest work was published after his death as "The Second Radium Report from the Memorial Hospital."[14]

With this background, I thought it right to devote this lecture to the "Achievement of Radium in the Fight Against Cancer," and to attempt a review of the whole field and not of any single or isolated achievement. This is perhaps a suitable occasion as it is the Fiftieth Anniversary of the discovery of Radium. Half a century is a short period, yet radium has achieved much; like all great additions to knowledge it developed by leaps and bounds. In the past ten years it has suffered loss of popularity with the development of roentgen therapy. This swing of the pendulum is yet a further reason for a review of what radium has achieved. The debt of science to radium can be subdivided into three broad groups—physical, biological and therapeutic. I will endeavor to review briefly these three achievements with special emphasis on the therapeutic side.

One year after the discovery of x-rays by Röntgen, a French physicist, Henry Becquerel, communicated to the French Academy of Science his observation that one of the natural elements, uranium, was spontaneously and continuously emitting radiation which, like roentgen rays, could penetrate matter. It took Marie Curie and her husband, Pierre, two years to isolate the new element—radium. The exact date of their first communication is December 26, 1898. So in an obscure shed, a frail young woman, working in poor conditions, discovered, isolated and studied some of the

* The thirteenth Janeway Lecture, delivered at the Thirtieth Annual Meeting of the American Radium Society, Chicago, Illinois, June 20–22, 1948.

properties of a new substance, the importance of which to the safety of future generations of mankind can hardly be overestimated. It can be compared in magnitude to the first conquest of fire by the ancestors of man in prehistoric time. And yet it was less than a brief fifty years, a mere fraction in the history of mankind, from the discovery of radium by Marie Curie in Paris to the dropping of the first atomic bomb by the American Army Air Force on Hiroshima.

The credit of the discovery of roentgen rays belongs to Germany, that of the discovery of radium to Poland and France. I think it is right to say that Britain may claim the first place in the systematic development of the laws of radioactive transformation. It was Rutherford in 1899 who first identified the alpha and beta particles of radium. This led him to draw accurate conclusions as to the structure of the atom and the mathematical proof of the existence of the nucleus of the atom. In 1919 he showed experimentally that a charged alpha particle could collide with the nucleus of an atom of nitrogen and break it up into two other atomic species, a step towards the artificial disintegration of an atom. Lord Rutherford is to radiotherapy what Lord Lister is to surgery. He deserved and received many honors, amongst them an LL.D. from the University of Pennsylvania and from the University of Wisconsin, a Ph.D. from Yale University and a D.Sc. from the University of Toronto; he was also made an honorary member of five American Scientific Societies. With the death of Rutherford in 1937, a great epoch in science came to an end. His biographer, Professor A. G. Eve, compares him to Galileo and Newton, who began and ended one such famous epoch—the discovery of the mechanism of the Universe; to Faraday and Maxwell who achieved the foundations of electricity, and to Einstein and Planck who opened the doors of relativity and of quanta.

Mention must also be made of Sir James Chadwick who, working with Rutherford at the Cavendish Laboratory, Cambridge, discovered the existence of the neutron; this discovery led to a complete revision of modern atomic physics and to the birth of nuclear physics. Thus the discovery of Radium and of the Laws of Radioactivity altered our conception of physical matter; The Law of Conservation of Mass and the Law of Conservation of Energy no longer held good. It was Marie and Pierre Curie's daughter Irene and her husband Joliot whose further contributions to the rapid advances of the new science resulted in the production of artificial forms of some radioactive substances. In all three fields—physics, biology and therapeutics—the Janeway Lectures of the past can be usefully used as landmarks in the progress made. This also gives one the opportunity of paying tribute to American pioneers both physicists and clinicians, as well as to those in Great Britain, France and Scandinavia who have contributed to the development of radium therapy.

PHYSICS

The application of radium to the treatment of disease resulted in a need of a unit of measurement of radiation and in the development of a new specialist, the "hospital physicist." In America, two past Janeway lecturers stand out in the front rank of such hospital physicists—Failla[8] and Edith Quimby.[22] Their contribution to the fight against cancer is accuracy in the clinical use of radium, measurement of tissue dose, dosage rate and the correlation of these with the biological effects. The establishment of the roentgen as a unit first in the measurement of roentgen rays and subsequently in that of gamma rays of radium produced further problems, as there is a difference between the two which to the clinician is quite obvious. On our side of the Atlantic, tribute must be paid to Professor Russ and Professor Hopwood—the first two to occupy the position of hospital physicist—to Mayneord, to Gray and to Wilson who by the intensive study of measurements of gamma rays raised the pres-

tige of British hospital physicists in the development of both interstitial and teleradium therapy. To Paterson and Parker of Manchester, we owe a simple method of dose measurement which has been adopted by all radium centers in Great Britian. To quote Edith Quimby—"in a period of twenty years, accuracy has evolved from chaos and we are now concerned with a detail in accuracy undreamed of a few years ago." Physicists have thus by close collaboration with clinicians, brought us nearer to solution of the problems of Science applied to Medicine. The weapon which brought them together is Radium.

BIOLOGY

The biological effects of radiation attracted the attention of pathologists, clinicians and biologists from the earliest days of radiation. The classical studies of Bohn[2] (1903), Perthes[19] (1904), Bergonié and Tribondeau[1] (1904), Dominici[5] (1907), Price-Jones and Mottram[20] (1914) laid the foundation of radiobiology. The key to the treatment of cancer by radium and roentgen rays is the variation in response of normal and malignant tissues to the effects of ionizing energy. The term radiosensitivity can be defined as the relative susceptibility of living cells to a given quantity of ionizing energy. It is the work of Regaud and Lacassagne, of Ewing, of Packard, of Mottram and the tissue culture studies initiated by Strangeways and so brilliantly continued by Canti, Spear and their collaborators at the Strangeways Laboratories, Cambridge, and many others, which have thrown light on the processes which affect radiosensitivity. The main factors can be subdivided into those related to normal physiological processes, to alterations in environment and those in relation to the physical conditions of irradiation. The normal physiological processes include mitosis, stage of embryological development and the type of cell. The factors dependent upon environment are those of metabolism, sepsis, anemia and secretory activity. The most flexible factors are those in relation to the physical conditions of irradiation: time factor, intensity, dosage rate, wavelength and the effects of previous irradiation. Side by side with biophysics, there developed in the last fifty years a new branch of biology—radiobiology. A vast amount of experimental work resulted in a better understanding of the pathology of tumors, a separation of neoplasms according to their degree of response to radiation. Thus radium has played an important part in the advances of other branches of medicine besides therapy, especially in pathology. Soon it became obvious that radiosensitivity is not synonymous with radiocurability, that the most spectacular rapid melting of tumors with small tissue doses meant, as a rule, rapid recurrence. It became apparent that histological structure, anaplasia and differentiation were not always a guide to prognosis. Glücksmann[10] and Glücksmann and Spear[11] suggested that to estimate the probable response of tissue to radiation, proliferation and differentiation must be considered not as isolated processes but in terms of the quantitative relation of these two processes to one another. From their work resulted the prognostic significance of serial biopsies and an assessment could be made if a given case was likely to be successful or to have an unfavorable course. The cells of the biopsy specimen fall into four categories: dividing, degenerating, resting and differentiating. An unfavorable response of a tumor to irradiation is shown by persistence of mitotic activity, no alteration in the number of resting or degenerating cells and no increase in the differentiating cells; in other words, no qualitative or quantitative alteration before and after irradiation. A favorable response to irradiation is shown by disappearance of mitosis, followed by disappearance of resting cells, and an increase in differentiating and in the degenerating count. It is now ten years since the first case so studied by serial biospies—a cancer of the uterine cervix treated by radium—was correctly forecast to be of good prognosis al-

though clinically a florid and an advanced tumor. It can be summarized that radium was, with roentgen rays, the tool of research by biologists and pathologists and that the knowledge thus acquired played a part in the treatment of tumors.

The question, "Do roentgen rays and radium produce different tissue reactions?" is today as important as it was twenty-three years ago when Ewing[6] in his Caldwell Lecture before the American Roentgen Ray Society (1925) discussed "Tissue Reactions to Radiation" Much technical progress in roentgenologic apparatus, voltage undreamed of then, neutron therapy, the cyclotron, betatron and the multimillion electron volt generators have since then become available and have been used. Can we today say with confidence that therapeutically roentgen radiation is equal in its curative results to that of gamma rays? The progress made in the past twenty years is very substantial but not in all types of tumor. It is obvious that roentgen radiation at one-half to one million volts produces biological effects similar to those of gamma rays. It is also true that in certain groups of neoplastic diseases—Hodgkin's disease, lymphosarcoma, Wilms' tumor and in the treatment of metastasis of many kinds, roentgen rays at 200 to 250 kv. have nearly entirely displaced radium. Yet there is a group of tumors where radium remains the better weapon, where regression of the growth is nearly always predictable and where permanency of results up to twenty and more years has been achieved.

It must be admitted that the use of radium clinically requires a certain amount of surgical skill when interstitial methods are chosen, and that the cooperation of a hospital physicist is essential when surface applicators, plaques or moulds are used; that teleradium requires absolute precision in beam direction, especially when narrow beams are used. All this makes roentgen therapy at the usual 250 kv. a simpler and easier method of treatment. There is also the factor of total tissue dose. I have used 9,000 to 11,000 roentgens to tumors of the tongue before the roentgen was defined and when I was not aware of the dose given. I have continued to give 9,000 to 10,000 r interstitially to the tongue and other lesions with greater precision, accuracy and safety since then. I am not aware that roentgen therapy has achieved such tissue doses, neither am I familiar with statistical proof that epidermoid cancer of mucous membranes can be treated with the same frequency of permanent success by roentgen rays as by radium. The swing of the pendulum from radium to roentgen rays began before World War II. In England it was given a great impetus during the six years of war, when the dangers from bombardment and other difficulties made radium an awkward therapeutic weapon. In some hospitals, nevertheless, teleradium and radium needles continued to be used, albeit with difficulty, practically without interruption. But the swing towards roentgen rays continued. I will remain content by giving a brief review of the treatment by radium of tumors in certain sites and let the achievement speak for itself.

CANCER OF THE UTERUS

No fewer than three Janeway lectures were devoted to Uterine Cancer—that by Henry Schmitz[23] (1938), Wm. P. Healy[12] (1942), and F. W. O'Brien[17] (1947). This in itself goes to show that the American Radium Society has found it a subject worthy of interest. The use of radium in cancer of the cervix is universal, methods have been developed in many countries. Thus we speak of the "Stockholm" method in honor of the pioneer work by Forssell and Heyman at the Radiumhemmet; there is the "Paris" method which differs in dose, timing and technique; there are many modifications, such as the "Manchester" method from the Holt and Christie Institute, the Donaldson-Neary method, where very large quantities of radium are used vaginally. Whatever the variation in technique it resolves itself in the insertion of radium into the uterine canal and the vaginal for-

nices. It has one drawback—the incidence of rectal injuries or burns. In a recent review of 3,392 cases of cancer of the cervix uteri at the Radiumhemmet, there were 313 rectal reactions, or an incidence of 9.2 per cent. Some clinics use roentgen rays as well as radium, mainly to supplement the parametrial dose and the dose to the pelvic wall outside the adequate range of the intracavitary radium. But it remains a supplementary and not the main treatment. What are the results? The most recent and accurate figures (Marie Curie Hospital, London; Holt and Christie Hospital, Manchester) show a *ten year* survival rate of 63 to 65 per cent in Stage I; 34 to 41 per cent in Stage II; 15 to 22 per cent in Stage III; and even in Stage IV, 8 to 4 per cent are obtained. Here is achievement by high ten year survival, by low operative mortality as compared to surgery, by broadening the field of therapy to all stages of the disease. Here is a lesion which is fatal in a mean average in twenty-one months if untreated, curable to the extent of 65 per cent in early cases by radium alone. Can other methods compete with this? There is no doubt room for surgery and room for roentgen irradiation as therapeutic measures, but only exceptionally if the results quoted are to be obtained.

CANCER OF THE TONGUE

I am perhaps more familiar with radium therapy in this site than in any other and I can speak from a personal experience of 365 cases.[3] I would like to postulate that in squamous cell carcinoma of the anterior part of the tongue, that is the tip to the vallecula, radium needles as the sole treatment have proved the most successful therapy and in the posterior or pharyngeal portion (the vallecula) teleradium is the method of choice. At Westminster Hospital, radium has been used for cancer of the tongue since 1924. It is still so used as the first method of treatment and as the only method of treatment in a well defined group of cases. Given a lesion of the tongue, limited to the tongue, radium gives 56 to 60 per cent of five year survival, in cases where the cervical lymph nodes are not involved. Surgery plays an important role in the treatment of operable lymph nodes, when a block dissection is performed. Radium is used if the nodes are deemed inoperable. I think it worth emphasizing that the insertion of needles into a tongue according to well known distribution rules delivers about 9,000 gamma roentgens to the tongue in seven days, that the reaction subsides in a month to five weeks, that in a very large proportion of cases (90 per cent) primary healing occurs, that in about 60 per cent healing is permanent—that is five, ten, fifteen, and twenty years if the patient does not delay seeking advice. Accuracy is essential, in the distribution of the needles, in their radium content, in their retention in situ over the desired period. It is a precise, delicate procedure, which requires planning and skill.

CANCER OF THE UPPER AIR PASSAGES

In discussing the place of radium in the treatment of cancer of the upper air passages, I would like to pay a tribute to Dr. Douglas Quick.[21] In 1937, he delivered the Janeway Lecture on "Carcinoma of the Larynx." His work on cancer of the mouth and upper air passages has been a source of inspiration and encouragement to my colleagues and myself. The present methods which have altered but little in the past five years are mainly teleradium with occasionally supplementary roentgen therapy. In the larnyx itself, the intrinsic group—carcinoma of the vocal cord, the ventricular band, the anterior commissure—offer the most promising cases. Fenestration of the laryngeal cartilage with insertion of needles, as introduced by Finzi and Harmer,[9] has been entirely superseded by teleradium. At Westminster Hospital the technique for laryngeal tumors consists in the use of three fields, left and right laryngeal fields and one anterior field. To overcome the difficulties imposed by the variations in the anatomical configuration of the

neck and by the position and extent of the lesion and to ensure an optimum arrangement for the fields in each individual case, H. T. Flint and C. W. Wilson[24] have constructed suitable frameworks which provide the position of the fields and the direction of the beam. The use of these frameworks permits the placing of the patient within a known field of radiation in preference to providing unknown fields within the patient. With the present unit, it takes four to six weeks to deliver 6,000 r homogeneously to the tissue within the framework of the larynx. At the end of the period of treatment, there is uniform membranous reaction spreading over both cords, the anterior commissure and the arytenoids. The regression of the lesion varies from case to case and with the gross macroscopical types—thus, the papillary growths regress quickly, the ulcerative more slowly. In successful cases 6,000 r is the maximum tissue dose needed and the vocal cords return to a normal appearance. In early cases, that is those considered suitable for laryngofissure limited to one cord, and when the cord is mobile, the appearance within six to eight weeks is indistinguishable from normal and so is the voice. In growths with subglottic extension the results are less spectacular. The advanced and neglected lesions, not suitable for any form of treatment except total laryngectomy, should preferably be treated by surgery, as radiation only exceptionally gives long term results; and much suffering can be inflicted by radiotherapy, be it radium or roentgen rays, in persistence of treatment of advanced and resistant lesions. At the Royal Cancer Hospital, London, M. Lederman, in a series of 40 cases of which 17 were early, obtained five years of freedom of disease in 70 per cent of cases. His series of endolaryngeal cancers between 1933 and 1946 consist of 96 cases treated solely by teleradium and support entirely my personal experience that teleradium, if given skillfully, accurately and in suitable cases, is the method of choice in this site.

Of the extrinsic group, the pyriform fossa carcinoma in men and the postcricoid carcinoma in women form the common groups. Here the results are much worse than in the intrinsic group. But as there is practically no alternative surgical treatment—few cases being suitable for pharyngectomy or laryngopharyngectomy—repeated attempts at improving technique have been made. The method of choice in my clinic is teleradium. Although the results are statistically insignificant, five to twelve year survival has been obtained sporadically in a small number of cases. In these, complete regression of the lesion has been obtained; in the majority of cases palliation only is achieved for two or three years. The problem is still unsolved.

NEOPLASMS OF THE MAXILLARY ANTRUM

In this situation, radiotherapy has completely altered the prognosis. I will deal in this contribution with the treatment of carcinoma of the antrum. Sarcoma of the antrum, rare and radiosensitive, is equally well cared for by roentgen irradiation. But in the carcinoma group a combination of surgery with radium therapy has proved a valuable method. It is based on the approach devised by Öhngren[18] and consists in the transpalatal access to the tumor, the removal of the hard palate and the destruction of the growth by diathermy; this is followed by intracavitary application of radium on a prosthetic appliance made for each individual patient. The dosage rate aimed at varies from 50 to 70 gamma roentgens per hour, and ten to twelve hours' treatment daily is given. A total of 8,000 gamma roentgens is aimed at. The advantages of this method can be summarized as follows: (1) it gives access to the tumor without any external mutilation; (2) it provides drainage of the maxillary antrum, the ethmoidal cells and, if necessary, the sphenoidal sinuses; (4) following irradiation there remains an inspection window and so recurrences can be seen at the earliest stage. Speech is restored by a dental plate carrying an obturator. My oldest patient,

now eighty-six years of age, has survived free from disease for twenty-two years following this treatment. In all, a small personal series of 55 cases so treated has yielded just over 50 per cent of survival with freedom of disease for five years upwards.[4] Many modifications of the method described are applicable; thus preoperative irradiation in all or partly, can be given by teleradium; or both preoperative and postoperative irradiation can be used. The surgical principle, however, is the same—transpalatal approach and the use of the diathermy, and radiotherapy is by intracavitary radium or by teleradium.

CARCINOMA OF THE BLADDER

Carcinoma of the bladder is a transitional cell carcinoma. Its three clinical varieties—papillary, ulcerative and nodular—are of similar histopathological type. The radiosensitivity of these growths is low, and a considerable tissue dose is needed to produce regression of the lesion. Of the main forms of radiation therapy—radium and roentgen rays—radium is to date undoubtedly the more efficacious. Roentgen irradiation as the sole method of treatment has, in my experience, failed to produce regression; a study of the literature supports this view. The main reason, I believe, is the difficulty to deliver to the tumor in the bladder a dose of roentgen radiation adequate to control the growth, although hemorrhage may be arrested or controlled. This fact is recognized and attempts have been made to raise the daily dose to 300 r or more, to use as many as six ports of entry, to push the treatment to the limit of skin tolerance, namely blistering. But these gallant attempts have not resulted in any great improvement, at least with the use of 200-250 kv. There are, however, indications that with higher voltage—1,000 to 2,000 kv.—and with improvements of both apparatus and technique, the position may change.

With radium the problem of adequate dosage can be solved by the use of interstitial radiation. In selecting the method of treatment the important questions are: What type of lesion is suitable for radium therapy? What is the technique of choice? What is the optimum total dose and dosage rate? The type suitable for radium therapy is a lesion of moderate size, located at the base or lower part of the bladder, of the infiltrating or ulcerative type. Small growth on the roof or sides, accessible growths of moderate extent can be dealt with by partial cystectomy; extensive lesions where complete regression by irradiation cannot be confidently anticipated should be considered for total cystectomy if the patient is fit and willing to undergo this ordeal. The papillary growths, if obviously malignant and still operable, are dealt with by a combination of diathermy and radium. If these criteria are applied, about one-third of all cases of carcinoma of the bladder are found to be suitable for radium.

As regards technique, the endoscopic method, that is, the introduction of radon seeds through a cystoscope, has naturally attracted the attention of urologists. It is suitable in early cases of localized growth in the absence of infection. Only a very few cases fulfill these desiderata.

The advantages of the endoscopic methods are outweighed by the following disadvantages: (1) The wall thickness of the seed is limited by the bore of the instrument; this means that the screenage is limited to 0.3 mm. of platinum; severe reactions follow and risk of infection is increased. (2) The distribution of small radium foci in regular geometrical pattern is difficult, with the result that, except in very small lesions, some areas are overirradiated, while others receive a sublethal dose. (3) The falling intensity of radon mitigates against the delivery of the necessary total dose without considerable risk of necrosis.

The technique of choice is accurate needling under direct vision through a wide suprapubic cystotomy. Suitable retractors, adequate exposure, good illumination provide the necessary access to the growth. A choice of needles of various lengths, but

of similar linear intensity, must be available; screenage should be preferably 0.8 mm. of platinum. The actual distribution of the needles depends upon the anatomical configuration of the lesion; most growths can be adequately treated by a single plane implant; patterns previously prepared for different lesions are used. The total dose aimed at is high, namely 7,000 to 8,000 gamma roentgens. It can be achieved without inflicting burns if the dosage rate is about 35 to 45 gamma roentgens per hour; with such low intensities the total time of irradiation is about nine to ten days. The amount of radium required is small and varies according to the volume of tissue to be treated and its surface extent. The needles must be placed accurately in position and steps taken to ensure that they stay in position. An area of at least 1.5 cm. of apparently normal bladder should be irradiated beyond the periphery of the lesion. Like all surgical procedures, the needling of the bladder requires care, skill and patience; it also requires training and practice. But, above all, it is not a treatment which can be carried out unless special facilities are available in specially equipped institutions. The closest cooperation between urologist, radiotherapist and physicist is a sine qua non. It is this absence of cooperation which has given needling of the urinary bladder rather a sinister reputation associated in the minds of many with burns, cystitis, urgency, frequency, uncontrollable pain resulting is miseries compared with which the natural distress of cancer of the bladder pales into insignificance. I emphasize this point, as it is essential not to gloss over the difficulties or the dangers of the method. Results, however, have justified this treatment and apparently total regressions up to a period of ten years have been achieved. The treatment of cancer of the bladder by radium is as much a surgical procedure as diathermy or excision—it should enlarge and not diminish the urologist's field of usefullness.

CANCER OF THE SKIN

I will say little of the benefits of radium in the treatment of cancer of the skin, as this is well known and still holds its place equally with roentgen rays. I will content myself with the mention of one skin lesion, epithelioma of the penis. In this site, early cases treated by needling regress with little mutilation and no undesirable side effects. Advanced and extensive lesions, involving the urethra, the corpora cavernosa or the corpus spongiosum are not suitable for radium; in such cases surgery must be resorted to in spite of the grave mutilation it inflicts. In early cases, needling with radium has achieved freedom of recurrence up to eighteen years.

CANCER OF THE BREAST

As a palliative measure for recurrences or in the treatment of inoperable cases, radium has long been in use. Geoffrey Keynes,[15,16] however, was the first to treat operable and early cases by radium as an alternative to radical amputation. Radium therapy in breast cancer has been superseded by roentgen therapy, but it played an important part in the development of radiation therapy in this site. Needling of the breast, either alone or in association with surface plaques, has given complete regression of the disease and survival rates very nearly equal to those of surgery in some cases. Radiation is of key importance in the treatment of advanced cases and as a preoperative measure. There can be no doubt that the prognosis in cancer of the breast can be materially improved by the judicious, careful and expert use of radiation either as the sole method of treatment or in combination with surgery. Early diagnosis remains the greatest single factor influencing prognosis. Preoperative and postoperative irradiation, preferably with roentgen rays, but in selected cases with radium, has not only improved end results, but rendered a larger proportion of patients amenable to treatment.

Successful radiotherapy of cancer depends primarily on a knowledge of the disease, its natural history, its mode of spread, its response to various methods of treatment and to various techniques of irradiation. Radiation is not a panacea for all cancer cases and should not be used to the exclusion of surgery, unless it is better than surgery. Similarly, radium should not be used to the exclusion of roentgen rays, or roentgen rays to the exclusion of radium; both methods have their advantages in certain sites; they are often complementary. If the benefits of treatment are to be obtained to the fullest measure, it is important to recognize the limitations of each method. No radiotherapy department can be adequate without facilities for both radium and roentgen therapy and a specialist trained in the use of both, and eager to use all methods. No cancer clinic can rely upon radiation alone, and surgery as well as chemotherapy has its very important place. It must unfortunately be recognized that quite apart from research purposes, the choice of the method of treatment is often dictated by the facilities available, by bias of the clinician to a certain given method of treatment and by prejudice against other methods. What is the achievement of radium? It is the therapeutic measure of choice in cancer of the uterine cervix, in cancer of the lip, tongue and mouth, in cancer of the larynx and the antrum, and the urinary bladder—all accessible tumors of moderate topographical extent, and medium grade of radiosensitivity. Radium is equal in efficacy and often more certain than roentgen radiation in cancer of the skin, including the penis and the anal canal. In highly radiosensitive tumors, lymphosarcoma, lymphadenoma, plasmocytoma, roentgen therapy should be preferred. In tumors of bone and in cancer of the breast, roentgen rays are preferable on the grounds of simplicity. In deep-seated and inaccessible tumors, technical difficulties preclude the use of radium.

In looking back on a quarter of a century of work with radium in the treatment of cancer, it seems clear that for its use, surgical as well as radiological training is of great importance and that lack of surgical ability limits the use of radium to external methods of treatment and these are more easy of accomplishment by roentgen rays. My impression is that apart from total dose and dosage rate, the biological effects of radium and roentgen rays, although similar, are not identical and this profoundly affects the long term results of treatment in most sites.

This review of the Achievement of Radium in the Fight against Cancer is based on the work done in the great clinics in the United States and in Europe—of these, three institutions fill the center of the stage —the Memorial Hospital, New York, the Radium Institute of Paris, and the Radiumhemmet in Stockholm. My own field of activity, the Westminster Hospital in London, has, in company with all other London teaching hospitals, passed through the war years with added difficulties. You may be interested to know that when the bombs were dropping fast, there was unveiled in 1943, in one of the radiotherapy wards of the Westminster Hospital, a tablet commemorating the fact that American citizens were supporting in that ward, beds for patients from London air-raid shelters. There is this added link which humanity has forged between us and this is an opportunity of bringing back our warmest appreciation which the passing of five years has mellowed, but not dimmed.

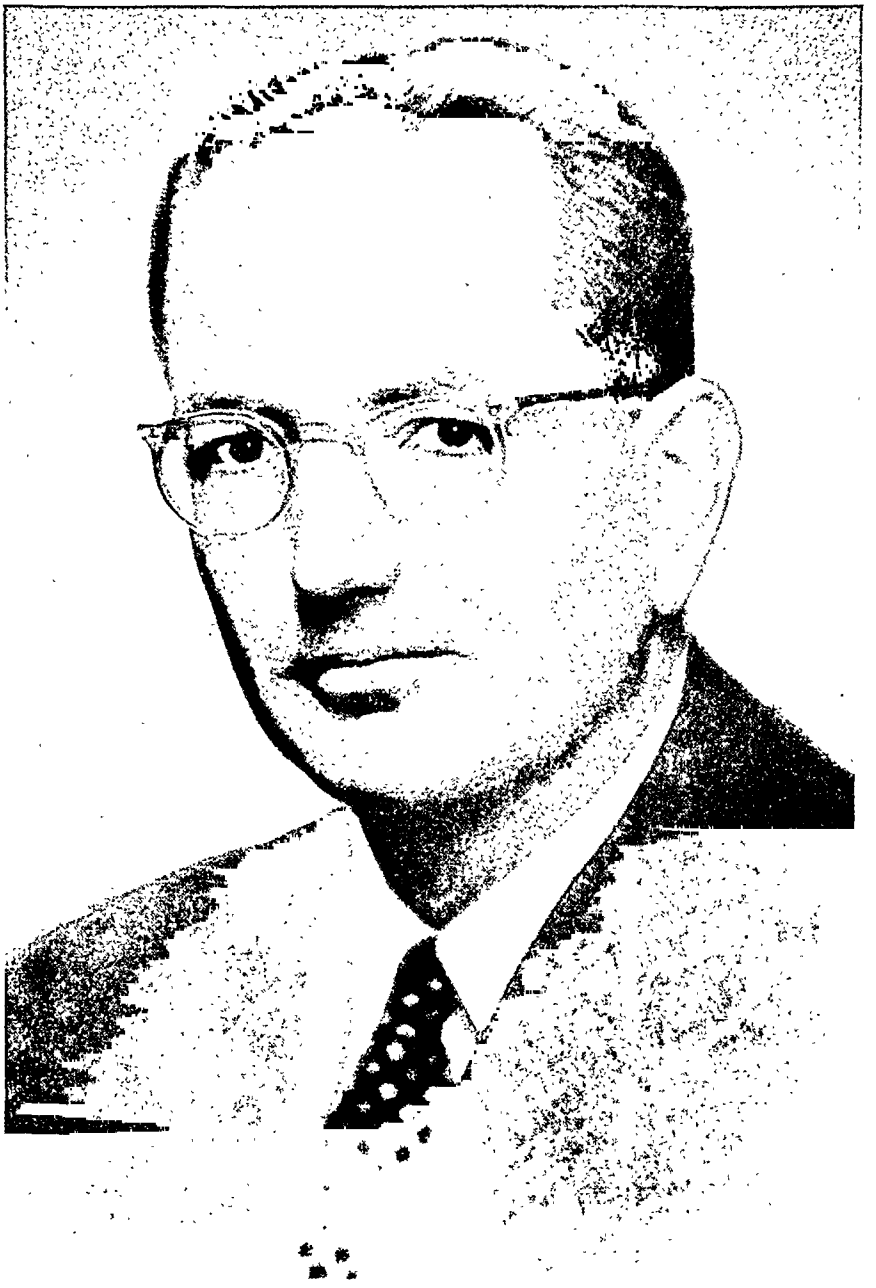
The achievement of radium can be counted in the years added to the lives of countless numbers of patients; this could be assessed statistically, but it is not possible to compute in figures, the relief of pain, palliation and temporary arrest of disease and prolongation of life which has been achieved in addition. The advances made in pure science cannot yet be fully understood. If my review of these achieve-

ments is incomplete and has many gaps, may I plead Hippocrates' first aphorism that "Life is short and the Art long; the Occasion fleeting; experience fallacious and judgement difficult."

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A CONCEPT OF THE CLINICAL USE OF RADIUM*†

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THE Thirtieth Annual Meeting of the American Radium Society occurs in a year of considerable historical significance. Nineteen hundred and forty-eight marks the Fiftieth Anniversary of the discovery of radium. It is appropriate that we take cognizance of that event. In planning a celebration commensurate with the occasion, a number of modifications have been made in the usual order of scientific and social affairs of the Society.

It is our good fortune to have several distinguished guests from overseas. Participation of those visitors in the scientific sessions elevates the program to an international level not attained before. Such an exchange of knowledge and experience is well timed after the lack of assembly incurred during the War years. The discussions to be undertaken will include problems to be met in further advance in radiation treatment. At one point on the program one of our members well suited to the task will pay tribute to the discoverers of radium, and elaborate upon the fascinating history of the development of radioactivity. We are apt to forget the profound impressions that fell upon early pioneers in the clinical use of radium. The degree of palliation obtained in patients with hopeless prognoses must have been in sharp contrast to that which was to be expected for any other method then in use. The relative simplicity of treatment in more favorable cases must have been in sharp contrast to the hazards of radical surgery. It is not surprising that tremendous enthusiasm was developed.

In this day and time we find radium occupying a somewhat different position in clinical practice. Methods of treatment have advanced beyond the stage of empiricism gained from experience by trial and error. Technical advances have resulted in the development of a number of different methods for administering electromagnetic or particulate radiations. The multiplicity of methods that can be used for irradiating tissue has lessened the preëminence of radium in clinical practice. Other factors have mitigated against interest in radium as a method of treatment. Advance in knowledge of medicine has extended the applicability of surgery. Some clinical departments have set out to explore again the use of certain operative procedures that had been more or less discarded. Any challenge that one method of treatment presents another is wholesome criticism that should result in improvement in clinical care. The researches in surgery have sometimes been interpreted, however, as trends in treatment. The impression is gained that the use of radium is decreasing. As a result, many inadequate operations are performed in pursuit of what is believed to be an established modification in clinical practice. Extension of that attitude will result in neglect of clinical study and clinical teaching, with recession in knowledge of the clinical use of radium in conditions for which it is indispensable. Radium may be replaceable by certain of the newer isotopes, but there is no foreseeable time at which gamma-ray emitters will not be essential for the focal intensities of irradiation required in the treatment of certain types of lesions.

Of the several technical developments that may have acted to replace radium as a method for irradiating patients, the most important has been the use of roentgen rays. Whatever that effect may have been, it would be expected to have occurred during the past twenty-five years. Begin-

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ning with 1922, spot surveys were made from the operating room record of the Barnes Hospital for every fifth year to 1947. For each of those years the number of radium treatments was determined as well as the number of patients treated. The number of radium treatments has increased at a somewhat greater rate than the number of patients. Those data were then correlated with statistics available upon total hospital admissions, excluding obstetric and pediatric patients. The increase in patients treated with radium has followed closely the increase in total hospital admissions. The ratio of radium patients to total admissions for 1932 is 1:56. For 1942, the value is 1:56, and in 1947, it is 1:55. There has, therefore, been no decrease in the use of radium at the hospital in question. Of the total number of radium treatments for the specified years, 57 per cent were applied for gynecological lesions.

TABLE I

STATISTICAL DATA FROM THE OPERATING ROOM RECORD OF THE BARNES HOSPITAL GIVING THE NUMBER OF RADIUM TREATMENTS FOR SPECIFIED YEARS. THE RATIO OF PATIENTS TREATED WITH RADIUM TO TOTAL HOSPITAL ADMISSIONS (EXCLUDING OBSTETRIC AND PEDIATRIC PATIENTS) IS SHOWN FOR CERTAIN YEARS

	Year					
	1922	1927	1932	1937	1942	1947
Radium patients	55	65	105	155	193	315
Radium treatments	57	66	110	170	208	361
Total hospital admissions			5,923		10,882	17,256
Ratio radium patients to total admissions			1:56		1:56	1:55

It is difficult to arrive at an accurate estimate of volume of radium work done each year in the United States. The May 1, 1948, issue of the *Journal of the American Medical Association* presents a list of 336 hospitals approved for training in radiology. The number of radium treatments performed annually is given for all but 81 of the named institutions. It can be assumed that data are incomplete for some hospitals not reporting radium treatments, and in others approval for training may have been granted on the basis that experience in radium treatment is gained by access of radiological residents and fellows to other affiliated clinical services or institutions. Hospitals approved for training in roentgenology or diagnostic roentgenology alone would not be expected to show a sizable number of radium treatments, but of the 235 designated for training in radiology or therapeutic radiology, 122 report fewer than 100 treatments per year. That indicates that radium is used more than twice a week in only 113 American hospitals. The number of treatments exceeds 300, about one per working day, in only 21 of those institutions. Four hospitals report more than 1,000 treatments, and the greatest single number is 4,227. The majority of radium work appears to be concentrated in about 6 per cent of the approved institutions. If the statistics here given are reasonably correct, then the number of institutions with a flow of clinical material adequate for sound teaching are limited in number. That is not intended to imply that quantity is an index of quality, but it is obvious that effective training depends in part upon experience gained by repetition.

Data given in a list of hospitals approved for radiological training are not intended to present a complete summary of radium work in the United States. There are several prominent members of this Society, for example, who perform radium treatments at institutions not set up for resident

and fellowship training. Furthermore, many patients are treated on an ambulatory status. It is unfortunate that probably most of that valuable material is lost for teaching purposes.

The clinical use of radium is distributed among dermatologists, gynecologists, radiologists, surgeons, and many others. There is in this country no standard qualification required of an individual employing radium in clinical practice. The absence of restriction upon ownership, rental, and sub-rental of radium makes the material available to all who find indication for its use. Lack of organization for administering the clinical use of radium is to a large extent responsible for the empirical procedures followed so frequently. It is probable that quality of radiation treatment varies more widely than does perfection of surgical technique and judgment. In the attempt to improve quality of work, it is not an uncommon practice for surgical divisions to require consultation, in specified circumstances, before performance of certain operations. Consultation upon use of radium is usually made only upon a voluntary basis, and in many instances in which advice is sought, the consultant gives an opinion expressed in terms of milligram-hours, without examination of the patient. Specification of a required treatment in total milligram-hours is no more precise than to state that a patient with a tumor mass requires a certain number of minutes of surgery.

It is obvious that one of the weak points in the system is the method of teaching. The time and effort required for adequate training in radiation therapy is as formidable as that needed for perfection in any of the surgical specialties. Basic knowledge must not only include anatomy, pathology, and physics of radiation, but also clinical diagnosis, biologic effects of radiation, and the natural history of tumors. Broad training of that scope is rarely provided in a single institution. It can scarcely be presented in a general radiological department in which the resident or fellow divides his time between roentgen diagnosis and radiation treatment. Neither is it likely to be supplied in any of the affiliated clinical departments employing radium. Adequate teaching material is to be found only in the larger centers. Adequate facilities for teaching might be attained in an autonomous department for radiation treatment. Graduates from such departments would elevate the standard of treatment procedures. The disappointing effects of too much or too little irradiation would be lessened. Exposure to disputes or changing trends in methods of treatment would be reduced. A more orderly advance in treatment of cancer would be attained.

Improvement in the use of radium cannot be separated from the general problems in radiation treatment. Attainment of a standard of teaching at the level in question necessitates centralization of clinical material and facilities as well as personnel in clinical medicine and the related sciences. Evidence that centralization of that order is going forward is indicated by the fact that large radium services are found in fewer than 10 per cent of American hospitals approved for radiological training. The point might well be made that the scope of radiation treatment is too broad for one individual. The same problem has been responsible for segregation of surgical specialties into limited anatomical fields. In the larger centers the processes of evolution might very well result in specialization into different anatomical divisions within the department of radiation treatment. In such departments it is not unreasonable to expect in some of the now recognized specialties the development of individuals engaged in the treatment of cancer by radiation or by surgery. The point of emphasis should be placed upon the importance of elevating the radiation therapist to the recognition that his specialty deserves. Active demonstration of the complexities of radiation treatment by performance of a high standard of precision instead of present empirical methods would bring realization of the hazards involved to other

members of the medical profession. That can best be done by elevating the standard of teaching. Mechanisms for controlling the administration of radium would then be less important. Fulfillment of those aims will advance and preserve our system of medicine. It is not to be implied that the centralization necessary for teaching is equally essential for patient care. With reasonable saturation of the need for highly qualified radiation therapists, clinical practice could be decentralized to a degree similar to that which is attained in the major surgical specialties.

Prerogative for expressing the aims here given is taken in the presentation of a presidential address. Certification of qualifications falls within the sphere of the various Specialty Boards. Standardization of minimal requirements for teaching the clinical use of radium will provide Specialty Boards with a uniform basis for establishing a suitable scheme of certification. Within the Society are the individuals most capable of providing the teaching and training required for modification of our present system. A study of the problems at hand should be one of the projects of the American Radium Society.

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EFFECTIVE DOSAGE LEVELS IN INTERSTITIAL RADIUM THERAPY

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THE early empirical techniques in radium therapy of malignant conditions were found to give good results in a number of cases. Quite often, however, the persistence or recurrence of growth and the appearance of necrosis showed only too well that faults of technique existed. Even in the best hands mishaps occurred which were not entirely due to the nature of the lesions dealt with.

In the past decade the empirical methods have been superseded. Dosage systems were devised whereby specific arrangements of radioactive foci are used in such a way that the dosage is known and controlled from beginning of treatment. The dosage system of Paterson and Parker (Paterson and Parker[1] 1934, Paterson, Parker and Spiers[2] 1936, Paterson and Parker[3] 1938) has proved to be sound, from both clinical and physical points of view, and is now adopted in most radiotherapy institutions.

By obeying the rules of their dosage system, irradiation at a uniform average level throughout the treated volume of tissues is achieved. It might be stressed, however, that there are finer details of implantation which obviously cannot be put in the form of rules as they apply to individual cases, in which experience teaches one how and where an "empirically" placed needle can make all the difference in obtaining the best result, and where the strict application of the rules is not feasible on anatomical or clinical grounds.

The distribution rules and charts in Paterson and Parker's dosage system answer two cardinal points which interest the practical radium therapist, i.e., how much radium is required and how it should be arranged in any particular case.

One of the outstanding problems facing the radiotherapist is that of the dosage levels, and the tumor "lethal" dose in the region of 6,000 r over a period of seven days, as suggested by Paterson, is a guide which has to be supplemented by experience and often by flair.

In this paper the problem of the amount of radiation to be delivered is discussed and an approach on novel lines postulated, and suggestions made which might be found helpful as a supplement to the Paterson and Parker dosage system.

According to the size of the implant the dose required for a given biological result varies and as suggested by Paterson in the biological section of his paper, 5,500 r to 7,000 r have to be given. In the assessment of the dose required only the volume of tissues to be treated is taken into account in the dosage system.

It is undeniable that the destruction of cells in the tumor area by ionizing radiations is not the whole story of the chain of events leading to the resolution and disappearance of the growth, and that many other concomitant factors come into play. Of these, the intrinsic resistance of normal tissues to malignant growth is worth remembering, and, although it is fair to assume that the organic barriers of resistance have been overcome at the time and site of appearance of the growth, a residual force undoubtedly remains and plays an important role in checking the growth. This local resistance comes more to the forefront when the balance of forces is upset by the effect of radiations.

It seems therefore necessary to take into consideration the area and volume of surrounding normal neighboring tissues which exert an influence on the behavior of the tumor. This amount of normal tissues through which nutritional fluids pass into the tumor territory and through which

toxic demolition products flow from the irradiated volume of tissues is of great importance. These tissues bear the brunt of radiation injury and contribute to repair. Taking into account not only the volume of tissues irradiated, that is, its size, but also its shape and the volume of the neighboring tissues, a rather more complete set of data is available for the assessment of dosage levels to be delivered.

In previous work[4] (Jolles, 1941) it was found that in animal experiments, the

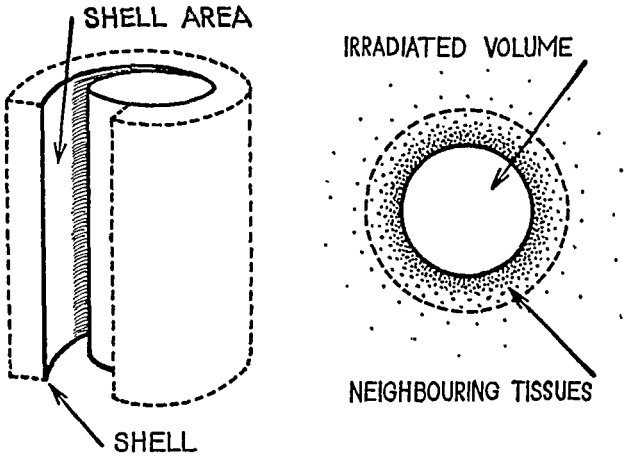


FIG. 1.

severity of skin reaction due to roentgen rays depends upon the size of the area irradiated, and by means of various devices (grid, sieve, anulus, etc.), it was shown that, the dose per unit area remaining unchanged, the reaction becomes a minimum when the adjacent normal tissues can exert their maximum protective role.

I have shown that:

(a) When small areas of skin (up to 3 cm. in diameter) are irradiated, the dose required to produce a given degree of skin reaction increases as the size of the field diminishes. Thus the degree of effect depends on the product dose-in-roentgens times area rather than on dose alone.

(b) If an area is irradiated through a sieve, the reaction produced is approximately the same as would be produced if the whole area were given a much smaller dose. Thus when a sieve was used, having 11 per cent of its area transparent, and 89 per cent opaque, the skin reaction produced was about what would be expected with a ten times smaller dose spread over the whole area.

Subsequently an attempt has been made to co-ordinate data obtained from clinical observations for the tolerance dose levels in deep roentgen therapy.

Working on the theory, based also on clinical experience, that the skin tolerance dose in deep roentgen treatment depends not only on the size, but also on the shape of the field, an empirical formula has been evolved enabling the optimal tolerance doses to be assessed under any condition of treatment. This has been arrived at by trial and error, the formula being amended from time to time according to clinical observations. The factor controlling the effect of the field was $\sqrt[3]{p/a}$ where p is the perimeter of the field and a the area (Jolles[5] 1946, Jolles and Mitchell[7] 1947).

Now considering a cross section of tissue of finite thickness in the path of a roentgen-ray beam, it is seen that the ratio p/a is also the ratio between the surface of the surrounding untreated tissue and the volume of the section. This suggested that the theory might be adapted to irradiation of blocks of tissue by radium (Jolles[6] 1946). In such cases the whole perimeter or shell surrounding the treated volume must be taken into account, so that the ratio $\sqrt[3]{\text{Shell}/\text{Vol.}}$ would be analogous to the ratio $\sqrt[3]{p/a}$ in the deep roentgen therapy case.

Knowing from clinical experience that a dose of 6,000 r delivered over a period of one week providing that the rules of distribution of the Paterson and Parker system are strictly obeyed, is adequate for a volume of about 75 cc., the relative effective dose levels for volumes of different sizes can be calculated. In Table 1 dose levels for cylinders of different sizes are presented, and although several of these are tentative ones, it appears within reasonable certainty that the doses suggested are the correct ones.

It is difficult to decide about the thickness of the shell of neighboring tissues

around the irradiated block that has to be computed, and therefore the area of the shell has been taken into consideration. This appears sufficiently accurate in cylindrical implant calculations with the following provisions:

(1) When one end of the implanted volume of tissues is on the surface of body or organ (skin, dorsum of tongue, etc.) or adjacent to a region from which no contribution to repair can be expected (mandible, terminal implants or moulds, i.e., in penis or fingers) the shell area to be computed is smaller and therefore the tolerance dose is correspondingly smaller.

(2) When one end of the implanted volume or plane is uncrossed by needles the values of the relative tolerance doses remain unaltered.

(3) Two plane implants with a separation greater than 1.5 cm. are treated as cubic volumes. A slab of tissue 0.5 cm. thick outside the radium needles in the planes should be included in the assessed volume.

Figures 2*A* and *B* are anteroposterior and lateral roentgenograms showing position of needles, with ring over lips, used for calculation of magnification factor. "George R." Ulcerated infiltrating squamous carcinoma of inferior aspect of tongue, with infiltration of floor of mouth. In this case an attempt was made to cross also the bottom end of the volume. However, only the anterior part of the tumor received an appreciable contribution from these "cross" needles.

"Volume" implant. Irradiated volume 55.5 cc. Shell area 62.8 sq. cm., $S/V = 1.13$. $\sqrt[3]{S/V} = 1.04$. Effective tolerance dose = 6,240 r.

Figures 3*A* and *B* are anteroposterior and lateral roentgenograms showing position of needles. One end uncrossed. "Henry D." Ulcerated growth on inferior aspect of tongue and floor of mouth, which is infil-

TABLE I

RELATIVE EFFECTIVE DOSAGE LEVELS FOR CYLINDRICAL IMPLANTS

Diameter cm.	Height cm.	Vol. cc.	Shell Area		Shell/Volume		$\sqrt[3]{S/V}$		Relative Doses	Relative Doses
			Total	One End Neglected						
			(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)
2	2	6.28	18.84	15.7	3.0	2.5	1.44	1.35	8000 r	7700 r
	4	12.56	31.4	28.26	2.5	2.25	1.35	1.305	7400	7450
	6	18.84	43.96	40.82	2.34	2.17	1.325	1.29	7200	7400
	10	31.4	69.08	65.94	2.2	2.1	1.3	1.273	7100	7270
3	2	14.2	33.0	25.94	2.33	1.83	1.32	1.22	7200 r	6950 r
	4	28.4	51.9	44.8	1.83	1.58	1.22	1.16	6650	6625
	6	42.6	70.7	63.6	1.66	1.49	1.18	1.138	6450	6500
	10	71.0	108.4	101.3	1.53	1.43	1.15	1.12	6300	6400
4	2	25.1	50.2	37.66	2.0	1.5	1.26	1.14	6900 r	6500 r
	4	50.2	75.3	62.76	1.5	1.25	1.14	1.07	6250	6100
	6	75.3	100.4	87.86	1.33	1.17	1.1	1.05	6000	6000
	10	125.6	150.8	138.2	1.2	1.1	1.06	1.03	5800	5900
5	2	39.2	70.6	51.0	1.8	1.3	1.21	1.09	6600 r	6250 r
	4	78.4	102.0	82.4	1.30	1.05	1.09	1.013	5950	5800
	6	117.6	133.4	113.8	1.13	0.97	1.04	0.985	5650	5620
	10	196.0	196.2	176.6	1.0	0.90	1.0	0.965	5500	5500

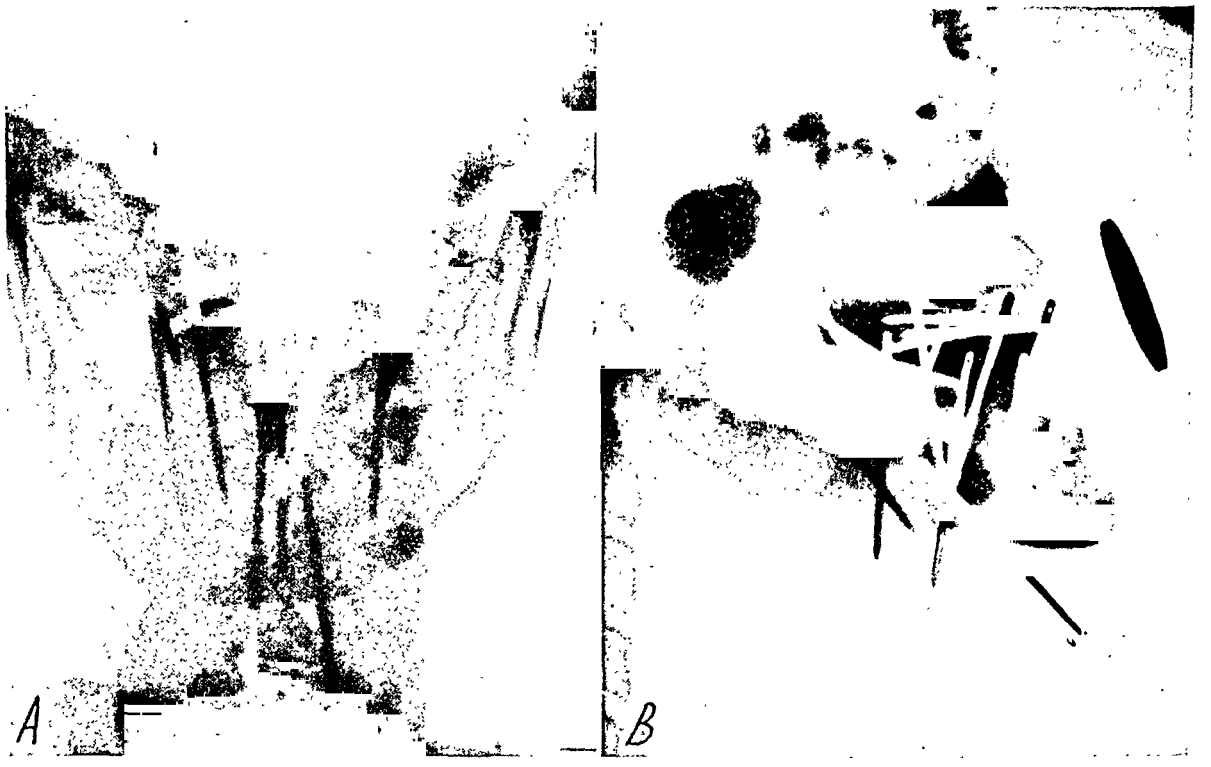


FIG. 2. *A*, shows correct position of needles. The two needles crossing the lower end of the cylinder do not reach the posterior parts of the treated volume but their contribution to the tumor area is not negligible in this case. *B*, the ring (*R*) on the lips of the patient is used for calculation of the magnification of the needles for irradiated volume assessment.

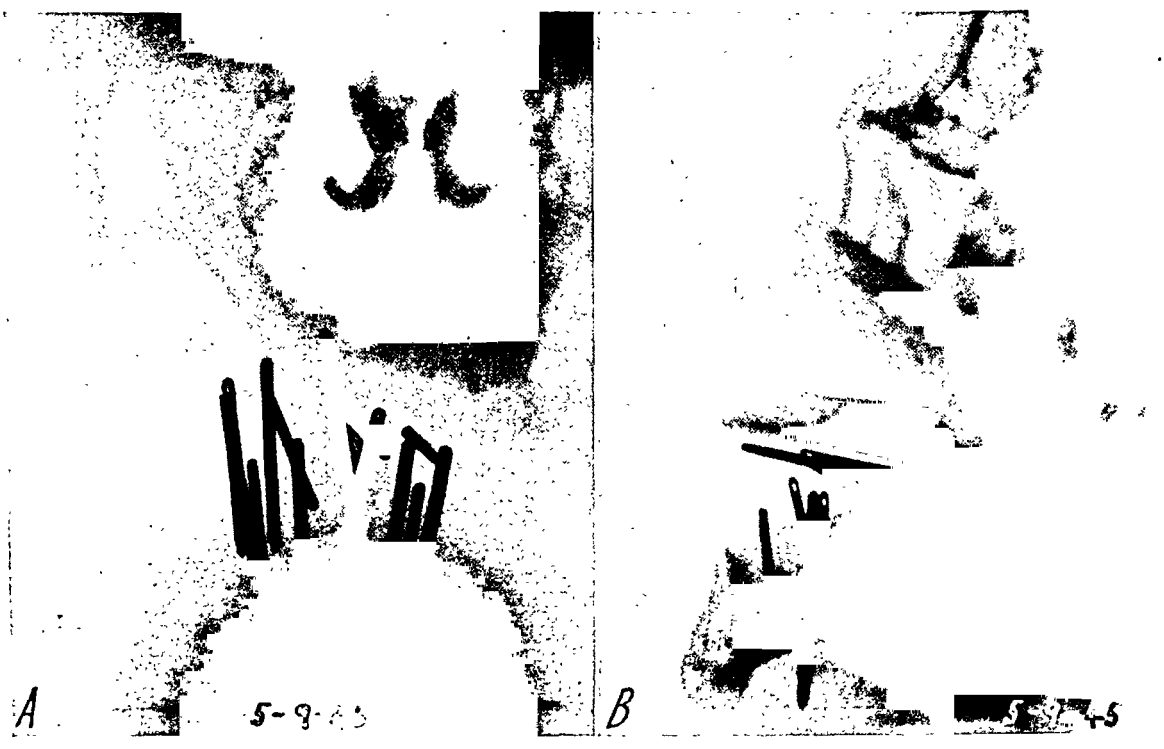


FIG. 3, *A* and *B*.

trated almost to the alveolus, but without bone involvement.

"Volume" implant. Irradiated volume 50.0 cc. Shell area 62.5 sq. cm. $S/V = 1.25$. $\sqrt[3]{S/V} = 1.07$. Effective tolerance dose = 6,400 r.

The aim of destroying malignant growth by means of high doses of roentgen or gamma rays has led in recent years to an increase of dosages, and the time has now been reached when a reconsideration of tolerance dose levels is overdue. Both experiment (genetics) and clinical findings show that there are many concomitant physiological factors which come into play in the treatment of tumors besides the direct effect of roentgen or gamma rays on malignant cells. It is therefore reasonable to assume that the maximum permissible dosages are not necessarily the best ones, even if these fall short of early or late necrosis (Ellis[8] 1942, Windeyer[9] 1942, Koller and Smithers 1946).

In the described method of dose assessment an attempt is made to conciliate two seemingly opposing views:

(a) The delivery of an effective and adequately high dose of radiation.

(b) The preservation of the connective tissue structures which contribute to repair and recovery.

Although in interstitial therapy one can hardly be up to the accuracy implied in this article and tables, yet the attempt to account for the area surrounding the implanted volume seems worth while, as these represent the unknown factors exercising an influence on the treated volume of tissues.

SUMMARY

A quantitative method of assessing effective tolerance dose levels in interstitial radiotherapy of malignant growths is described.

The importance of the perimeter/area ratio in deep roentgen treatments and of the shell/volume ratio in radium therapy is stressed.

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TREATMENT OF ADVANCED CANCER INVOLVING THE EAR*

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ALTHOUGH much has been written about the treatment of cancer of the skin it is our impression that malignant lesions involving the ear receive relatively poor care in general practice and we are in complete agreement with Pfahler and Vastine[10] who state that "a greater percentage of failures occur in the treatment of cancer in the region of the ear than in any other relatively superficial portion of the body." For this reason many such patients are applying to tumor clinics for treatment of recurrences following surgical procedures, the application of caustics, drugs or roentgen and radium therapy. Carcinoma of the ear may be said to be advanced when the lesion involves the entire ear, when invasion is observed in the auditory canal or the surrounding structures, or when metastatic lymph nodes can be felt in the cervical region. It is worthy of note that 72 per cent of 57 patients with these findings entering our clinic from 1939 to 1947 had been treated unsuccessfully elsewhere.

TREATMENT

No single therapeutic measure has been universally successful in our hands and various combinations of electrosurgery, roentgen therapy and radium therapy have been used. Some authors believe that irradiation necrosis in cartilage can be prevented by the utilization of proper techniques but this painful complication was observed in many of our cases following treatment received elsewhere, and it seems evident that many of those who use irradiation are not successful in preventing cartilage damage. Although heavy filtration reduces this damage to a minimum and we have used it on occasion with good results it is now our custom to remove all cartilage showing malignant invasion with electrosurgery before starting irradiation. This procedure produces immediate relief of discomfort, tends to shorten the healing period and seems to improve the chance of cure. Certainly it should be carried out immediately in those cases showing malignant tissue growing about an area of irradiation necrosis.

After local anesthesia has been induced with butyn (0.75 per cent) the diseased portion of the ear is clamped in a hemostat and removed rapidly with the cutting current. The electrode consists of a large darning needle held in a long insulated handle. The incision is made through normal tissue well outside the malignant area. If a bleeding vessel is observed a coagulating current is applied for a few seconds through a hemostat which is immediately removed. The wound is never sutured and rapid healing is the rule if the cartilage does not protrude above the skin edges. For this reason the cartilage is always trimmed down well below these edges with a pair of sharp curved scissors. When the skin is allowed to heal over protruding cartilage the resulting stump is very tender and the patient cannot tolerate even slight pressure over it. Very large lesions often necessitate the removal of the entire auricle and the deeper portions must be extirpated by blunt dissection. When possible a portion of the upper auricle is left in place so the glasses may be worn with ease. In certain instances active carcinoma is observed growing about the edges of a slough produced by over-irradiation of an area situated near the ear. An attempt is made to cut away all of the devitalized tissue with sharp curved scissors at the same time that the diseased cartilage is removed.

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FIG. 1. Large squamous cell carcinoma, Grade 1, involving the ear, adjoining structures and auditory canal, treated by electrosurgery and radium needle implantation. The lower photographs were made six weeks and nine months following treatment. The implantation required eight 2.4 mg. and three 1.33 mg. radium needles.

Poor results following surgery alone are due to the extension of the malignant process into the tissues adjacent to the ear and the procedures described above are looked upon merely as proper preliminary measures which prepare the patient for radiation therapy. Radical operations designed to remove all of the deep-seated cancer not only fail to bring about this result in many instances but frequently damage the parotid gland and produce a facial paralysis.

Immediately after the completion of the operation a plan of irradiation should be instituted designed to completely eradicate all of the residual cancer. Although we favor the use of radium, good results have been obtained in skin cancer with a divided dose roentgen technique[8] described in 1935. A daily dose of 315 roentgens, measured in air, is given to a 10 by 10 cm. field until twelve doses are given using 200 kv., a target-skin distance of 50 cm. and a filter of 0.5 mm. of copper and 1.0 mm. of aluminum. The total irradiation given amounts to 3,780 r but calculations published in a recent article[7] indicate that the effective dosage in the depths of a tumor measuring 2.0 cm. in thickness becomes 2,176 r with backscatter or 3.2 threshold erythema doses when due allowance is made for the time factor. In 1935 Merritt and Rathbone[9] published data showing that the incidence of cartilage necrosis was markedly reduced when a minimum filtration of 2.0 mm. of copper or its equivalent was substituted. This valuable change in technique was soon adopted in our clinic. These authors used 220 kv. with a target-skin distance of 25 cm. and for an area measuring 1 by 1 to 3 by 3 cm. administered 6,000 r in nineteen days using a daily dose of 350 r, measured in air. By applying the methods advocated by Quimby and MacComb[11] and allowing for the effect of the time factor, the dose delivered to the surface amounts to approximately 3.8 T.E.D. With the same factors they administered a total of 4,500 r to areas measuring 10 by 10 to 15 by 15 cm. in twenty-two days at the rate of 200 r per day. This technique delivers approximately 3.7 T.E.D. to the depth of a tumor measuring 2.0 cm. in thickness. Although we have adopted the increase in filtration we have continued the use of a dose of 3.2 T.E.D. given in two weeks which we believe to be as effective as 3.7 T.E.D. given in approximately three weeks.

Heavy filtered radium therapy given entirely with surface applicators is advocated by Pfahler and Vastine[10] while Driver and Cole[1] favor the use of implanted low intensity radium needles. The latter method is our choice because dosage calculations are easier, the approximation of the radioactive sources to the diseased tissue is more accurate and the time of treatment is shorter. The needles used in our clinic have been fully described in previous articles.[2,4,6] They are made of platinum, have a wall thickness varying from 0.5 to 0.6 mm. and contain 0.6 to 0.8 mg. of radium per centimeter of active length. The needles found most useful have active lengths of 0.5, 1.5 and 4.0 cm. and contain 0.66, 1.33 and 2.4 mg. of radium, respectively. They are inserted into the malignant areas in patterns which deliver doses varying from 6,000 to 12,000 gamma roentgens to all of the cancer cells in a period of seven days. In most cases electrosurgery leaves a layer of tissue for implantation and the method used in dosage calculation is described in a recent article.[7] When the malignant tissue extends into the outer portion of the auditory canal, 0.66 mg. needles are inserted vertically into the walls of this passage.

Metastatic lymph nodes in the neck are treated with a combination of implanted low intensity radium needles and roentgen therapy using a technique described in previous articles.[3,5] A layer of low intensity needles is placed in the lymphatic bed containing the palpable nodes so that they deliver the same dose as that used for the primary lesion and 350 roentgens are then administered daily to the same area with 220 kv. roentgen-ray equipment until a total dose of 2,100 roentgens has been given while the needles are in place. A primary filter of 2.0 mm. of copper or its equivalent



Fig. 2. Large squamous cell carcinoma, Grade 2, of the face which extended beneath the entire ear, treated by electrosurgery and radium needle implantation. The lower photographs were made six weeks and three years after treatment. The implantation required twelve 2.4 mg. and six 1.33 mg. radium needles.

is used with a target skin distance of 50 cm. Each needle is sutured in place and the wound is dressed daily with boric acid ointment. All needles are removed at the end of seven days and boric acid ointment dressings are continued until healing has taken place. When good results are obtained the wound is usually healed in six weeks to

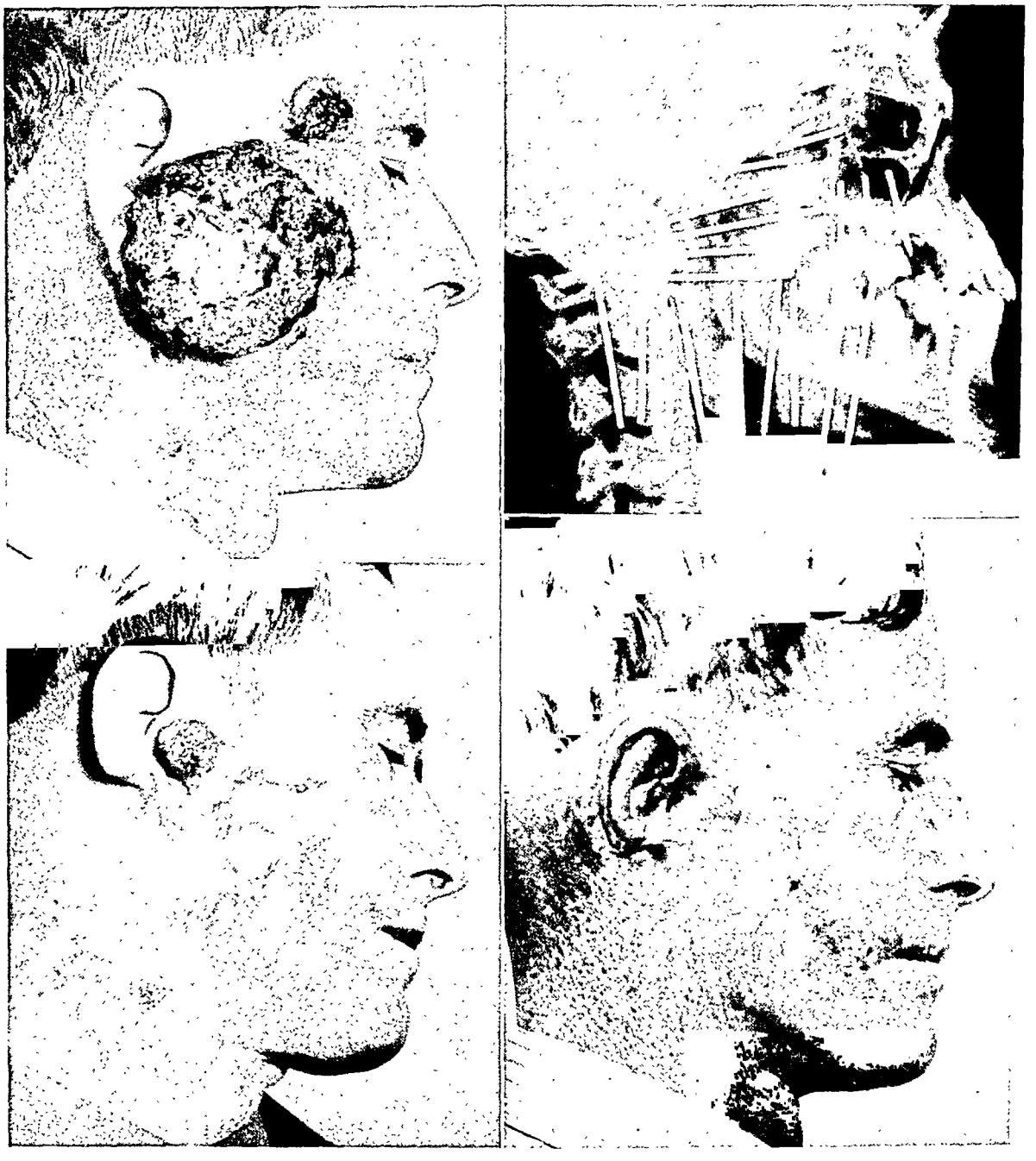


FIG. 3. Mixed squamous cell and basal cell carcinoma of the face involving the lower half of the ear treated by electrosurgery and radium needle implantation. The lower photographs were made six months and three and a half years after treatment. The recurrence in front of the ear was successfully treated with divided dose roentgen therapy given six months after the radium implantation.

three months, but occasionally a longer period is required.

Extension of the malignant process into the underlying bone makes the prognosis very poor and no cases of this type have been completely cured in our clinic. However, definite improvement has been produced with the heavily filtered, divided dose roentgen-ray technique described above. No radium needles are used in such cases.

COMPLICATIONS

The intensive irradiation advocated by us depresses the function of the parotid

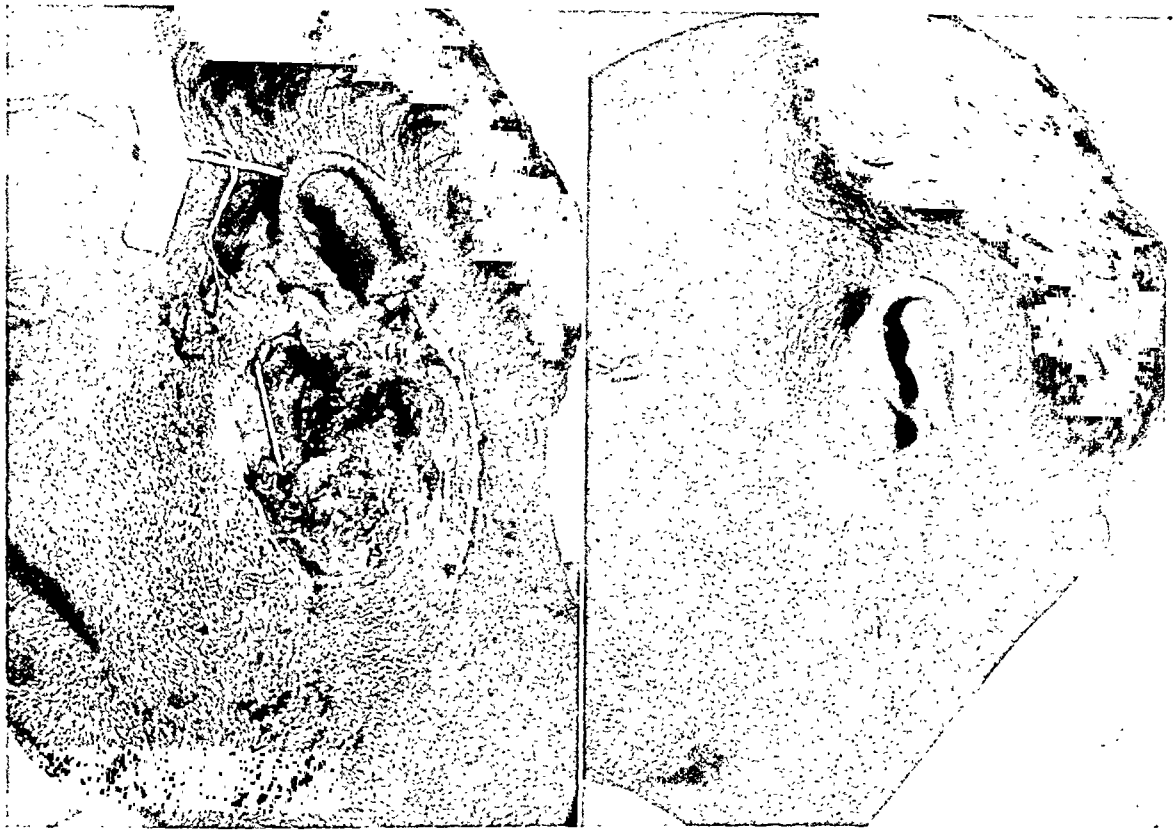


FIG. 4. Large deeply ulcerated squamous cell carcinoma, Grade 4, of the face involving the lower half of the ear treated with electrosurgery and radium needle implantation. Twelve 2.4 radium needles were implanted as shown in the photograph on the left. The photograph on the right was made five years later.

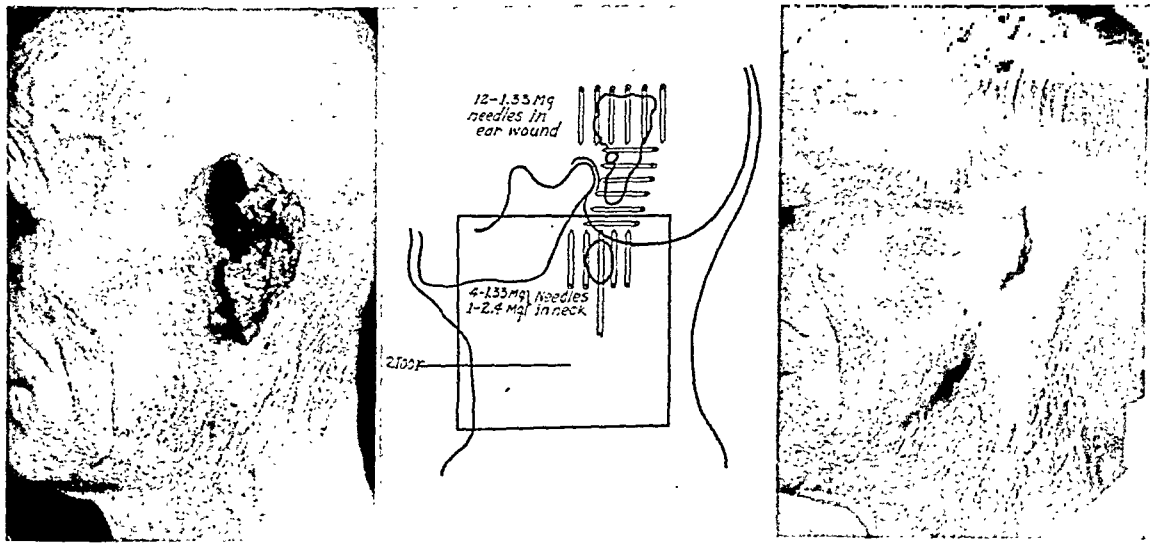


FIG. 5. Squamous cell carcinoma, Grade 2, involving the entire ear with a palpable node in the neck, treated by electrosurgery and radium needle implantation. The node was treated by a combination of radium needles and roentgen therapy. When the photograph on the right was made five months after treatment the gland was not palpable.

gland on the treated side for long periods of time and the patients complain of some dryness of the mouth, but the seventh nerve is never damaged and in no instance has a facial paralysis been observed after treatment. The first course of radiation therapy should always be designed to produce a cure and, as a rule, such treatment is not used a second time. If, as sometimes happens, large lesions are not completely eradicated and small recurrences are observed in the wound after healing they are destroyed with electrocoagulation. The skin behind the ear lies in close contact with the underlying bone and a slight overdosage in this region may produce a slough. Alvagel has proved useful in the treatment of this complication but in some instances a partial denudation of the outer surface of the mastoid has persisted. Although this end result is unsightly it seems to produce no real harm. When the surface of the bone is severely damaged it will eventually separate after which complete healing may occur.

As already stated any damaged cartilage in the treated area must be removed. The over-irradiation of a relatively small lesion on the anterior surface of the auricle with low voltage roentgen rays sometimes brings a patient into the clinic because of the severe pain produced by partial necrosis of the underlying cartilage. This complication can be quickly relieved by the careful removal of a button of cartilage from the treated area. If the skin on the posterior surface is left intact healing occurs rapidly and the cosmetic result is good.



FIG. 6. Deep-seated basal cell carcinoma extending into the auditory canal and beneath the ear treated with electrosurgery and radium needle implantation. The middle photograph and the one on the right were made six weeks and one year after treatment.

RESULTS

During the years 1939 through 1947 a series of 57 patients with advanced cancer of the ear has been admitted to our clinic. For the purpose of statistical investigation 35 of these cases treated three to seven years ago were studied. In 2, biopsy revealed mixed squamous cell and basal cell carcinoma but in the others these two types of cancer were about equally divided. The carcinoma involved the entire ear in 12 cases and extension well beyond the auricle was observed in 24 cases. The auditory canal was invaded in 7 patients and cervical nodes were palpable in two.

Only 9 of these patients are known to have died of cancer and 2 are still alive with some evidence of the disease present. Complete primary healing was obtained in

22 (63 per cent) and 18 (51.4 per cent) have remained well and free of disease for three to seven years of observation.

SUMMARY

Cancer involving the ear receives very poor care in general practice. Techniques are described which salvaged half of a series of 35 advanced cases most of which had been treated unsuccessfully elsewhere.

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MALIGNANT TUMORS OF THE CHEEK IN CHILDREN*

REPORT OF TWO CASES

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MALIGNANT tumors of the cheek in children are relatively uncommon. Helmholz[1] of the Mayo Clinic has reported 750 cases of malignant neoplasms in children under fifteen years of age. Of these, 7.47 per cent, or 56 cases, occurred in the "intra-oral and neighboring regions." Of 218 cases of childhood cancer observed at Memorial Hospital in New York, Dargeon[2] reported 37 tumors of the head and neck, an incidence of 16.9 per cent. Malignancies of the face in children are about 100 times less frequent than in adults.[7]

The 2 cases summarized below are of interest since both were children under six years of age, both occurred in the same position and both presented a similar therapeutic problem. One of these children (Case 1) is living and well five years after irradiation and excision; the other infant (Case 11) died of the neoplasm less than a year after its appearance.

CASE REPORTS

CASE 1. V. M. (Univ. Hosp. No. 8453). This four year old colored female first presented herself to the Surgical Clinic of the University Hospital on November 10, 1943. In September, 1943, the child fell while at play and struck the right side of her face and nose. She had a moderately severe nose bleed, but no swelling was noticed. About ten days later, she again struck the right side of her face and, on examination, the mother noticed a tender, firm mass below the right eye. During the next two months, the mass gradually became larger and much firmer. The area was not painful.

On November 10, 1943, she was seen in the Surgical Clinic at which time it was thought that the mass was independent of the injury.

Examination revealed the eyes to be normal. A firm irregular mass measuring 5 by 3 by 2 cm. that appeared to be attached to the anterior wall of the right maxilla was easily seen and palpated. There was no evidence of inflammation. The tumor was hard, non-tender and extended upward toward the glabella and involved the right portion of the upper lip. The floor of the right nostril was elevated and covered by purulent crusts. The right inferior turbinate was extremely swollen, but the other turbinates were normal. The right maxillary sinus did not transilluminate.

A roentgenogram of the paranasal sinuses revealed no pathological process. On November 26, 1943, an aspiration biopsy was attempted through the lateral nasal wall, but no material was obtained.

The diagnosis of a malignant tumor—probably sarcoma—of the right antrum was made and the patient admitted to the University Hospital on November 30, 1943.

A roentgenogram of the paranasal sinuses, twenty-three days after the original film, revealed clouding of the maxillary sinuses probably due to sinusitis, but a tumor mass could not be excluded.

The mass was felt to be a malignancy of the right face, probably having its origin in the soft tissues over the right antrum. On December 5, 1943, a biopsy of this mass was taken under general anesthesia through an incision in the mucous membrane of the superior alveolar process down to the maxilla. With blunt dissection, the incision was carried over the mass which was cut into and found to be firm tissue with a white appearance. Grossly, it appeared to be sarcoma. A piece of tumor mass was removed for study. The patient's postoperative course was uneventful. The pathologist's report was as follows (Sp 47686) (Fig. 1).

Gross examination: The specimen consists of small pieces (4) of white firm tissue, each measuring 0.5 cm. in diameter. Not significant grossly.

Microscopic examination: Sections of the

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material in this case show an edematous, partially hyalinized stroma infiltrated by tumor growth. The tumor cells are oval or somewhat spindle shaped. The nuclei contain much chromatin and stain deep blue. The cells invade the tissue in solid columns and as individual elements. This is a malignant anaplastic tumor. The exact classification is not determined. Metastasis from an adrenal neuroblastoma is a possibility which might be considered.

Impression: Malignant tumor.

Radiation therapy was thought to be the method of choice because of the age of the child and the location and size of the mass.

On December 14, 1943, the child was returned to the operating room and under general anesthesia, 19 platinum iridium needles, each containing 2 mg. of radium element, were implanted into the tumor, so distributed that the needles were about 1 cm. apart, in two layers—one layer being just anterior to the bony wall of the antrum and one layer being more superficial. Two of these needles were run across the upper lip beneath the skin where some firm tissue had been palpated.

The needles were left in place for a period of 157 hours, giving a total dose 2,993 milligram-hours, or 7 threshold erythema doses.

The needles were removed without difficulty, and the area healed well for about ten days. Following this, there was marked reaction of the skin and irritation of the eyelids with loss of the cilia. The skin over the area became quite red, hot, and swollen. The central portion of the area became necrotic and healed slowly to an area 2 by 3 cm. The patient was discharged from the hospital in excellent condition on February 1, 1944.

The child was followed closely in the Oncology Clinic and the area of slough healed almost completely. The patient had some inconstant pain in the area. On October 10, 1944, two months after her last visit, the child came to the clinic with the area almost completely broken down and secondarily infected. Nine days later, a large piece of dead bone (the zygoma) was removed, and following this, the area began to heal only to break down again in about three weeks. The patient was readmitted to the hospital on November 28, 1944, one year less three days from the first admission.

Examination at that time revealed a deep ulcer over the right face extending from the right nose to the level of the external canthus and from the lower right eyelid to the vermilian border of the upper lip. The lower lid was everted exposing some 3 mm. of reddened conjunctiva. Bony spicules arose from the depths of the wound which was bathed in a foul smelling, grayish pus. A deep sinus drained almost constantly from the upper medial border of the ulcer. The lateral wall of the right nostril was eroded, the wall being formed by a



Fig. 1. Case 1. Photomicrograph of anaplastic malignant tumor.

dull gray sequestrum. There was a profuse purulent discharge into the right nostril. Two upper right deciduous molar teeth were present, but the upper right canine and both incisors were absent. The patient's temperature was spiking to 102° F. every day.

The area was cleaned with hot, wet normal saline dressings directly to the ulcer. The right eye was protected by ophthalmic sulfathiazole ointment.

On December 8, 1944, under general anesthesia, the area was cleaned with alcohol and the anterior and medial bony walls of the maxillary sinus were lifted out en masse. The sinus was filled with a gray cheezy material that had

a very offensive odor. Portions of the alveolar process of the right maxilla were rongeured away and all remaining upper right teeth—both permanent and deciduous—removed. The posterior, superior, and lateral walls of the antrum were found covered by healthy mucous membrane. The area was packed with iodoform gauze.

The child was much improved after this, pain decreased and the odor was no longer offensive. The iodoform gauze was removed on the fourth postoperative day, and hot, wet compresses started. The area healed satisfactorily.

The defect (Fig. 2) was closed (Dr. E. A. Kitlowski) by tube grafting from the lateral aspect of the chest. The graft took well and the child was discharged as improved on June 17, 1945. Repeated biopsies of the area prior to grafting showed no evidence of the original growth.



FIG. 2. Case 1. Defect in face following treatment with 7 threshold erythema doses of radium given by interstitial route.

The patient has been followed in the outpatient department and has no evidence of recurrence. At present, the graft is excellent, but there is a marked ectropion, right, and a pulling up and out of the right side of the nose and upper lip due to scar tissue (Fig. 3). Further plastic repair is to be carried out in the near future. An early opacity of the right lens is questionably present and is probably an irradiation cataract.

CASE II. J. P. (Union Mem. Hosp. No. 105020). A small swelling about 2.5 or 3 cm. below the left lower eyelid was first noticed by the parents when this child, a white female, was about eight months old. Apparently, there was no birthmark or mole in the region. There was a history of a questionable injury while the child was playing, but there was no break in the skin. This tumor was removed surgically (Dr. H. A. Bailey, Charleston, W. Va.) when the child was ten months of age. The pathological diagnosis was "embryonic carcinoma." In the same month, five 15 mg. radium tubes were inserted into the wound (Dr. E. W. Squires, Charleston, W. Va.). The tubes were spaced about 1 cm. apart and were allowed to remain in place for five hours, a dose of 375 milligram-hours. From August 25 to September 4, 1942, she was given roentgen therapy, 200 roentgens per day for a total of 1,800 r. The factors used were 200 kv. at 50 cm. skin target distance, through a 3 cm. portal with 0.5 mm. copper filter.

A recurrence was noticed in December, 1942—four months after the original tumor was removed. At that time, the patient appeared healthy, had not lost weight, was lively and played about as a normal child. There was a single well healed scar parallel with the left lower eyelid and about 2.5 or 3 cm. below it. No local recurrence was seen in the scar. Above and medial to the scar, a mottled redness and swelling was noticed, especially below the inner half of the lid. Beneath the skin in this area, there was a hard lump which was fixed to the nose, but could be rocked back and forth. The temporal half of the lower lid was edematous and the nasal half showed some infiltration. There were no enlarged cervical glands.



FIG. 3. Case 1. Defect closed by plastic repair. Further improvement in appearance is expected by contemplated operations.

A roentgenogram of the antrum and skull was reported as showing a slight hyperplastic sinusitis, but no definite evidence of bone involvement in the left antrum. The roentgenograms of the skull were negative.

Because it was felt that this tumor was probably radioresistant, and because of fear of damage to the eye and bones of the face, it was advised that excision and immediate plastic repair be attempted.

Operation December 14, 1942 (patient was not under our care at the time) revealed that the growth had penetrated the nasal and maxillary bones. No line of cleavage was found. As much of the tumor and periosteum were removed as possible. Because of the extent of the tumor, it was felt that removal of the bony structures was not justified since this tumor had progressed beyond control.

Pathologic Report (Sp 24180) (Fig. 4). There is a rather mixed structure of large masses of small deeply staining cells, with round and oval spaces, suggesting either lymph spaces or an attempt at gland formation. This same kind of cell has infiltrated a dense hyalin fibrous tissue such as we see in mixed tumors of salivary origin. In some areas these cells stain rather darkly. Impression: Low grade malignant tumor arising from aberrant salivary tissue.

COMMENT

Sarcomas are thought to be far more common in childhood than in adult life. Helmholz[4] reports an incidence of 97 per cent sarcomas and 3 per cent carcinomas in 714 childhood malignancies. In a series of 16,565 malignancies, Pack and Lefevre[9] report 26.7 per cent were in patients under twenty-five years of age whereas 1.2 per cent of the carcinomas were in patients younger than twenty-five years. Thus sarcomas are twenty-two times as frequent as carcinomas in persons under twenty-five years of age.

Friedman and Rubenfeld[14] have reported 5 cases of cancer in children under fifteen years of age including 2 spindle cell sarcomas of the mouth and cheek. Sarcomas arising from the soft tissues of the face are not uncommon, but these tumors in general are found to be of a rapidly growing and highly malignant nature leading to the early death of the child.

In adults, malignancies of the face tend to occur in areas of chronic irritation and are usually more slowly growing and well differentiated, but in children the malignancy may occur in any area and tends to be more rapidly growing, more rapidly fatal, and more anaplastic.

Salivary tumors occur in children and infants, but are much more common in adults. Pack and Lefevre[9] report that 0.81 per cent of mixed tumors of the parotid gland occur in children under four years of age and that 2.43 per cent of these tumors occur under the age of fourteen years. Salivary tumors have been reported as occurring at the age of six weeks,[3] eleven months,[10] and one year.[6,9] About 10 per cent of the tumors which show the typical histopathologic picture of a mixed tumor of the salivary glands are found outside of the parotid, sublingual and submaxillary glands.[8]

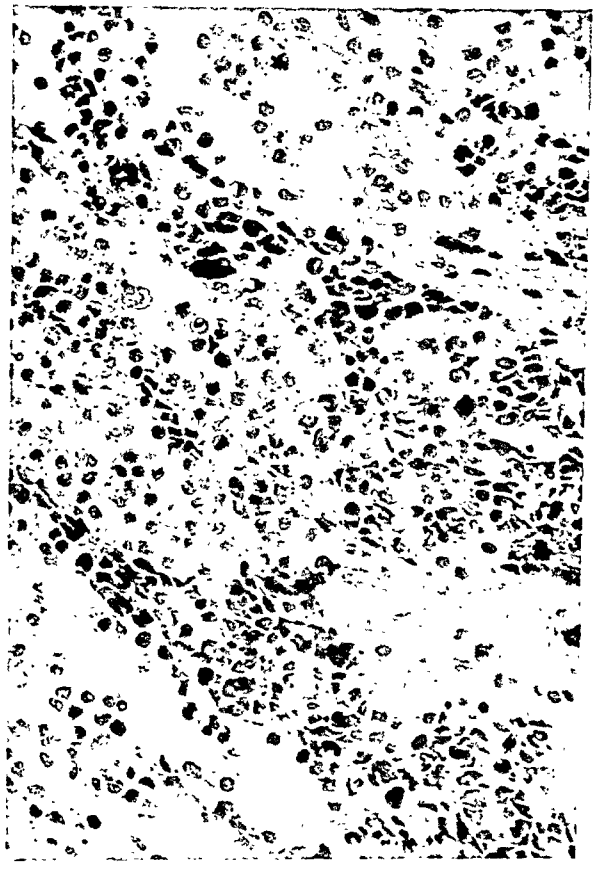


FIG. 4. Case 11. Photomicrograph of tumor. Note a more adenomatous arrangement than seen in the tumor of Case 1.

Many authors[1,6,11] have reported the presence of normal salivary tissue in the cheek explaining the origin of salivary tissue tumors outside of the glands proper. Wood[13] states that 25 per cent of all mixed salivary tumors become malignant, a figure that corresponds to the 28 per cent reported by Kuttner.[5] Reports of malignancies arising from aberrant salivary tissue in children have not been found in the literature. Pack and Lefevre[9] report the occurrence of a plexiform epidermoid carcinoma of the parotid region in front and below the right ear in a boy, aged four. In spite of two attempted surgical excisions and palliative radium therapy, the child succumbed to the malignancy six months after its appearance.

The therapy used in these 2 cases is of interest in view of the results obtained. The older child (Case I) received a large and relatively early course of radium therapy. The dose was a necrotizing one and has caused considerable deformity of the eyelid and upper lip, but with one or more plastic procedures, a good cosmetic result is to be expected. She has had no recurrence and is living a normal life and is doing well in school, five years later. The infant (Case II) received a relatively small dose of radiation, but the process continued and caused the death of the child. The favorable result obtained in Case I is due in part to several factors: the localized nature of the tumor, the early use of a large dose of radium, and the sensitivity of the tumor to radium.

Although salivary tumors of the cheek are rare, the possibility of their occurrence should be recognized and early therapy instituted. Sarcomas and malignancies developing in aberrant tissue in children are rapidly fatal and hope of cure is inversely proportional to the length of time between the appearance of tumor and institution of adequate therapy.

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CANCER OF THE LOWER LIP

SURVEY OF THE END RESULTS OF TREATMENT; ALL CASES TREATED AT THE BROOKLYN CANCER INSTITUTE 1930 THROUGH 1944

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IN THE fifteen years from 1930 through 1944, 112 cases of cancer of the lower lip applied for treatment at the Brooklyn Cancer Institute. This report continues the follow-up on cases reported by Howes and LaRosa[3] and incorporates additional cases treated since 1940. Whenever possible, all patients were traced to 1947, allowing a minimal follow-up interval of two years and a maximum of fifteen plus years.

Lesions arising on the lower lip are on an exposed surface and accessible to biopsy, pathological proof in this series is therefore 100 per cent.

RACIAL AND HEREDITARY TENDENCIES

In the existence of the Brooklyn Cancer Institute not a single member of the colored race has applied for treatment of cancer of the lip. This in spite of the fact that there is a large Negro population in Brooklyn and fully 10 per cent of all clinic and hospital admissions are of this race. Members of the colored race are known to have a high resistance to all forms of skin cancer, including melanoma.

Other than the apparent racial resistance to lip cancer in the Negro, no hereditary factors were disclosed.

ETIOLOGY

(*a*) *Intrinsic Factor.* Only 2 of 112 patients are women (1.7 per cent). The fact that this disease is almost exclusively limited to members of the male sex, a phenomenon which holds true to a certain extent throughout the respiratory epithelium, such as the larynx and bronchus, leads to the deduction that action of male hormone or some substance related to the male hormone must be a dominant intrinsic causative factor which sensitizes the lip epithelium to various extrinsic irritants.

(*b*) *Extrinsic Factors.* The incidence of a single injury to the lip followed by development of carcinoma is almost unheard of. As previously noted, "only one man had been struck on the lip and had noted the nodule after the trauma; another patient remembered an insect bite at the site where the lesion appeared" (Howes and LaRosa[3]). No additional case reports suggesting a single trauma as a possible causative factor were uncovered.

Blood serological studies were made in almost 100 per cent of the series. Only 8 were reported to be strongly positive with 3 others borderline. Tertiary syphilis must have passed unrecognized in an additional small number of instances. With less than 10 per cent giving clinical or serological evidence of this disease, syphilis can hardly be considered in the etiology of lip cancer.

The frequency with which leukoplakic spots were found on the mucous membrane side, and the frequent presence of atrophic keratoses on the carmine surface of the same lip involved with cancer indicates that a neoplasm is apt to develop in the background of degenerative change (Fig. 1, *A* and *B*). Furthermore, most of these men had dirty mouths, such as dental caries and chronic inflammation of the gingiva. This, however, may be a coincidental finding as obviously a large number of individuals who have extensive intraoral sepsis will never develop lip cancer.

Fully 90 per cent of the men had smoked a pipe, cigars or cigarettes throughout many years. Neither of the 2 women had used tobacco in any form. Although smoking has increased among women fully 1,000 per cent in the last generation, there has been no corresponding increase in the incidence of lip cancer.

In this series, the men were usually of the

unskilled laboring class. As a rule, they have worked outdoors during most of their adult life. Their faces and lips have been exposed to sun, wind, sleet and cold. Chapping as a result of exposure is a common occurrence. Theoretically this repeated chapping with resultant attempt to repair sets up an ideal situation purported to favor the origin of cancer.

The lip does not possess that protective mechanism which is common to the rest of the epidermis, namely, the ability to build up pigment. Thus ultraviolet rays are not filtered out as they are on other body surfaces and they can therefore penetrate into the living malpighian and basal layers to take full carcinogenic effect. The protective action of lipstick is here admitted. The number of our young men who developed carcinoma of the lower lip after serving in the Tropics with the armed forces leads to an emphasis on the presence of a carcinogenic factor in solar radiation.

The peculiar immunity of the upper lip to these same extrinsic factors is difficult to explain, except to note that the sun's rays strike the upper lip less directly. In this series only one man had a corresponding lesion on the adjacent surface of the upper lip, a phenomenon seen so frequently in a similar pathological type of carcinoma arising on the vulva in the female.

PATHOLOGY

The carmine surface of the lip is singularly devoid of the usual accessory skin structures common to skin. It is therefore logical that all carcinomas arising on the lip should be of the squamous cell type. Scanning the pathological reports in this series but one basal cell carcinoma is listed. The lesion in this instance appears to have arisen near the angle of the lip and may therefore have originated in the line of a fetal cleft, a site where basal cell lesions so frequently appear.

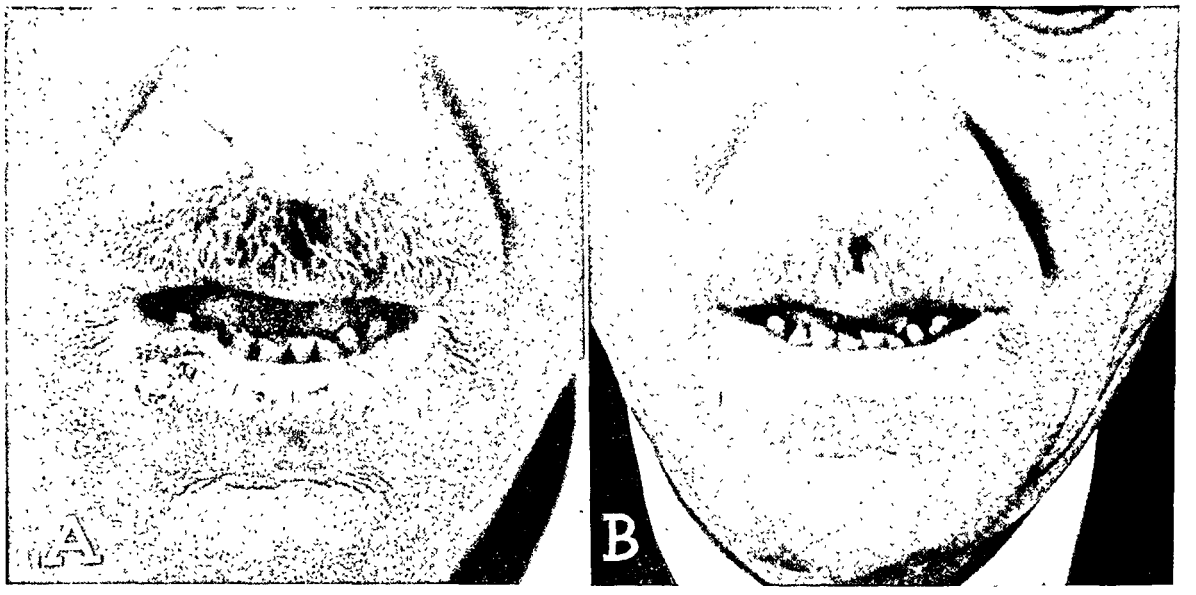


FIG. 1. M. C. Case C2629. *A*, presence of multiple lesions on carmine surface of lip, July 18, 1940. *B*, end result following roentgen therapy, January 8, 1942.

DIAGNOSIS

Because the lip is such a labile, actively moving part, any induration in and about a carcinoma quickly cracks to the surface and ulcerates. The buttonlike induration surrounding the base of such an ulceration may simulate chancre. Dark field examination and biopsy will differentiate one from the other. Antisyphilitic treatment should never be used as a therapeutic test without biopsy, as improvement following a few in-

jections of penicillin is prone to lull the therapist into apathy. A positive serological test for syphilis cannot rule out carcinoma.

Rhagades usually occur at or near the angle of the lip, while carcinoma more frequently arises somewhere within the middle third of the lip on its carmine surface. Rhagades should respond promptly to trial vitamin therapy. Biopsy will confirm clinical opinion.

Sunburn and herpes labialis can hardly be confused with carcinoma. Sunburn follows overexposure to sun. Protection from further exposure should result in healing within a week to ten days. Herpes labialis usually follows or accompanies a debilitating illness. The punctate vesicular character of the lesion in its early appearance does not simulate carcinoma.

A difficult problem of procedure is posed when biopsy of a suspicious lesion fails to demonstrate carcinoma. One such case was reported twice as benign, only to be diagnosed as carcinoma after surgical excision of the questionable lesion. Apparently in such instances infection with granulation tissue overlies the neoplastic cells.

TREATMENT

Successful treatment of cancer depends largely on early diagnosis. Those arising on the lip are no exception to this rule. A lesion on the lip should be obvious to the individual's sense of sight and touch. In spite of the obviousness of any lesion on the lip, the history of duration from the patient's statement in this series varied from one and a half weeks to twenty years. If the patient himself is indifferent, his family, friends and acquaintances cannot fail to observe its presence. The time elapsing between the recognition of the presence of a lesion and the seeking of medical aid averaged 13.7 months. As a corollary the majority of carcinomas when first seen were widely ulcerated, many measuring over 2

TABLE I

	Total	Average Duration Follow-up	Glandular Extension	Treatment Results	
				Success	Failure
Surgery	6	5 yr. 3 mo.	1	5	1
Roentgen therapy	55	4 yr. 10 mo.	8	44	11
Contact roentgen therapy	4	5 yr. 5 mo.	1	3	1
Radium mold	10	4 yr. 3 mo.	2	8	2
Interstitial radium	13	6 yr. 5 mo.	0	13	0
Surgery followed by roentgen therapy	6	4 yr. 8 mo.	1	5	1
Surgery followed by interstitial radium	2	1 yr. 2 mo.	0	1	1
Radium mold followed by roentgen therapy	2	1 yr. 9 mo.	2	0	2
Interstitial radium followed by roentgen therapy	12	4 yr. 5 mo.	6	5	7
Radium mold followed by interstitial radium	1	7 yr.	0	1	0
Roentgen therapy followed by interstitial radium and surgery	1	9 yr.	0	1	0
Totals	112		21	86	26

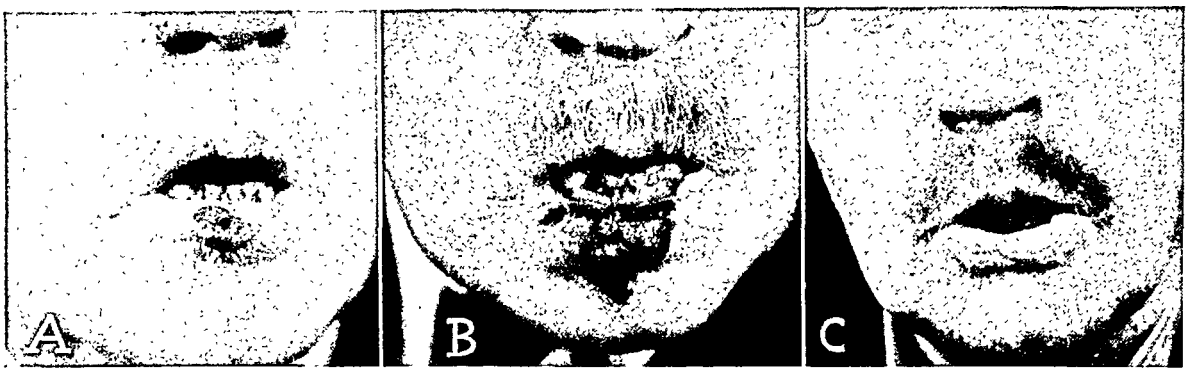


FIG. 2. P. Mc. Case 2317. *A*, appearance of lesion before roentgen therapy, March 18, 1940. *B*, height of reaction illustrating size and shape of area treated, May 2, 1940. *C*, end result, September 3, 1940.

cm. in diameter. Eleven of these individuals (10 per cent) had palpable submental, submaxillary or cervical glands at the time of their first visit. An additional 21 (18 per cent) developed palpable lymph nodes some time after treatment was instituted, a number of whom must have had unrecognized metastatic lymph node extension at the time of their original examination.

Carcinomas of the lower lip have been successfully eradicated by: (1) surgery, (2) irradiation, and (3) combined surgical and radiological procedures.

(1) *Surgery*. Surgery has its rightful place in the treatment of cancer of the lip. Such surgery, however, must be extensive and to succeed the surgeon must assure himself that he is able to excise tissue well beyond the obvious cancer zone. Closure should follow with suitable plastic procedure to prevent puckering, so-called "fish mouth" deformity. If submaxillary or cervical lymph nodes are involved, a further radical neck dissection may be indicated (Duffy[1]). Six cases were treated by surgery. One developed metastatic glands in the neck and died within six months. The remaining 5 cases are being followed through the clinic averaging over five years, a highly satisfactory result.

(2) *Irradiation*. The lip, by its superficial position and ease of approach, affords the radiologist many advantages, in that a cancerocidal dose can be delivered within a

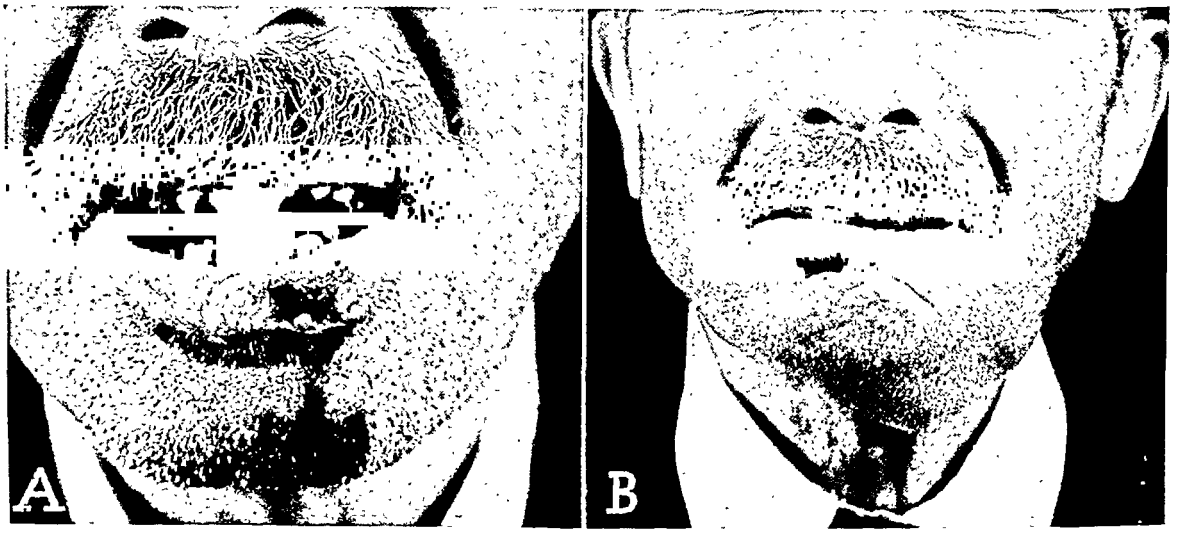


FIG. 3. S. B. Case H4082. *A*, appearance of lesion before therapy, September 17, 1940. *B*, end result of roentgen therapy, April 29, 1941. Note the metastasis in the submaxillary triangle.

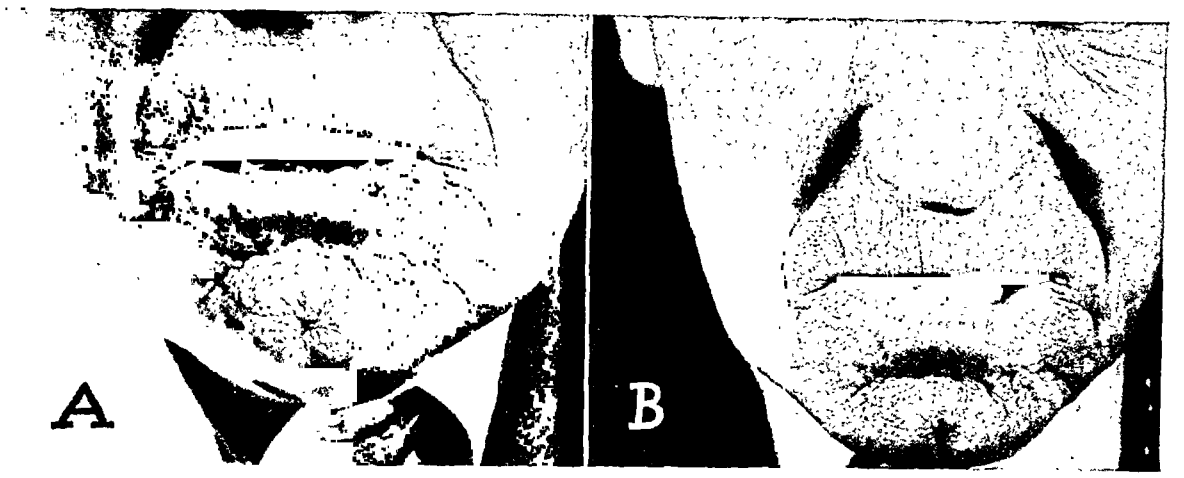


Fig. 4. A. S. Case 6676. *A*, lesion before therapy, March 29, 1939. *B*, end result, November 9, 1939.

given interval of time and surrounding normal structures can be protected from injury.

(A) Roentgen irradiation (superficial and deep): The technique of roentgen therapy to the lip as carried out at the Brooklyn Cancer Institute has varied throughout the years. Those cases treated before 1936 received superficial therapy, i.e., 80 to 135 kv. with half-value layer of 1 to 3 mm. aluminum. The lesions were blocked within 0.5 cm. of the obvious cancer and a single dose of 4,000 to 6,000 roentgens (measured in air) delivered (Howes[2]). After careful study of these results it was decided to enlarge the treatment area to a V-shaped configuration, similar to the segment to be removed if surgery were contemplated (Fig. 2, *A*, *B*, *C*). To protect the mouth and mandible, a shield of lead impregnated rubber was inserted between the lip and alveolus. Furthermore, the single massive dose was broken up into eight to twelve fractionated daily treatments (Fig. 3, *A* and *B*).

The technical factors used are: 200 kv., Thoraeus filter, half-value layer of 1.8 mm. Cu, 30 cm. target skin distance, 600 r in air delivered daily. The effort is made to deliver a total air dose of 7,200 r within two weeks (Paterson[6]). Recurrences have taken place when the dose was reduced to 4,500 r or less. An intense radiation reaction results from such a series of treatments; this

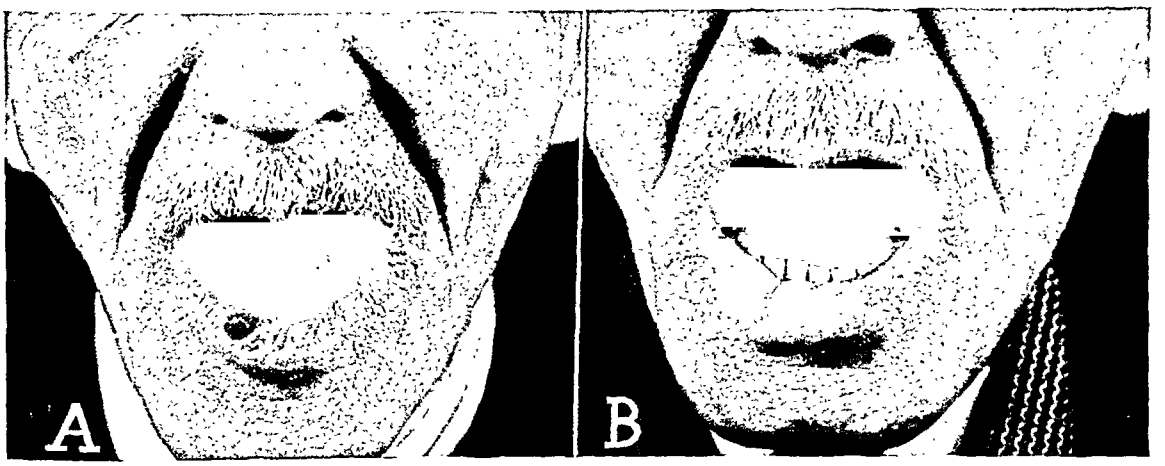


Fig. 5. S. R. Case 5891. *A*, appearance of lesion before therapy, July 1, 1940. *B*, end result, January 23, 1941.

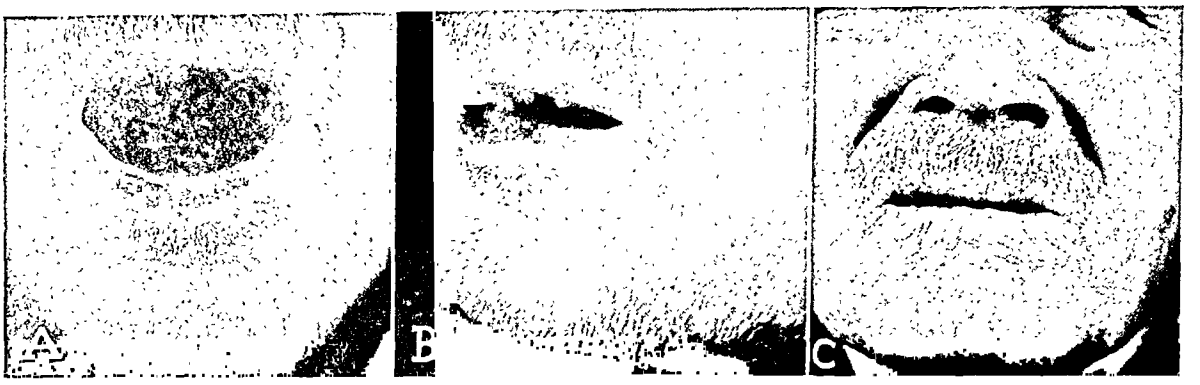


FIG. 6. A. B. Case C6197. *A*, appearance of lesion before therapy, April 18, 1940. *B*, lateral view before therapy. *C*, end result October 14, 1940.

is followed by healing with scar formation. Using this technique, necrosis with failure to heal has never complicated the end result (Fig. 4, *A* and *B*). Filtration is added theoretically to minimize telangiectasis and scar atrophy (Fig. 5, *A* and *B*). Extensive lesions involving most of the lower lip have been successfully treated by this technique and the resultant scar is soft and pliable and does not give the patient any discomfort (Fig. 6, *A*, *B*, *C*).

Fifty-five cases were treated by roentgen therapy.

Of the 11 cases treated by a single massive dose of relatively unfiltered radiation, 6 developed metastases. These cases (males) were listed as failures; most were followed through the clinic for approximately one and a half years when they were either lost to follow-up or died.

Forty-four cases received divided dose roentgen therapy as described above. The primary carcinoma was destroyed in each of these 44 instances. Two of this subgroup, however, later developed cervical glandular metastases and a block dissection of the neck was carried out (Fig. 7, *A* and *B*). Both these cases have reported back to the out-patient clinic, a duration of nine and ten years respectively.

(B) Contact roentgen therapy: Four individuals were treated by the air-cooled contact roentgen therapy using 45 kv., 2 ma., 2.1 cm. target skin distance, half-

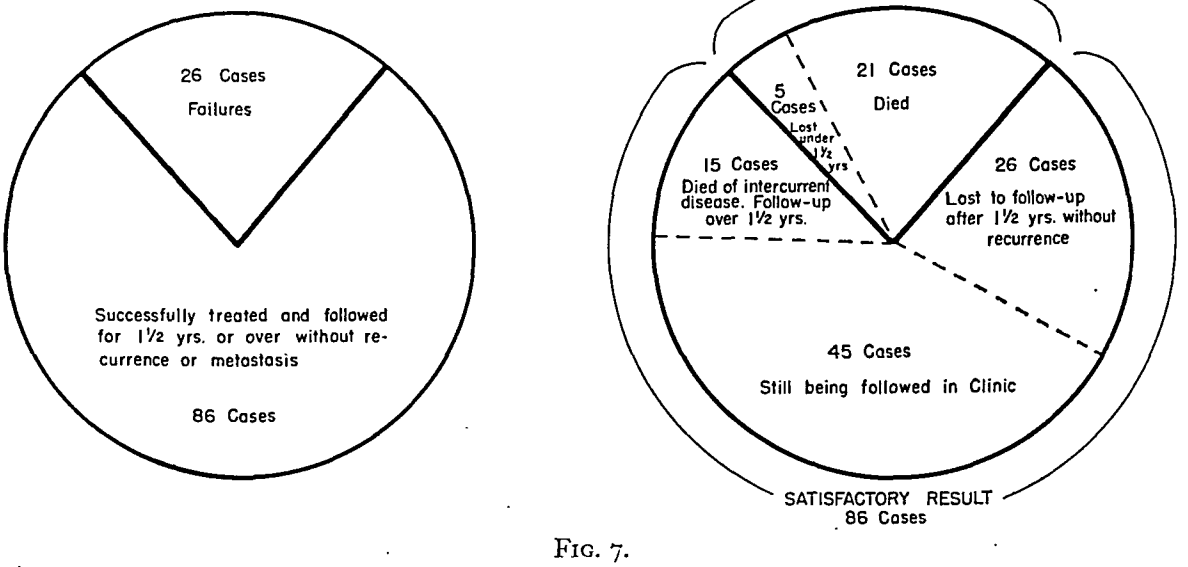


FIG. 7.

value layer 3 mm. aluminum, as described by Howes and Camiel.[4] The lesions were blocked off to about 0.5 cm. of their edge by lead foil. Three of these patients whose lesion measured over 1 cm. in diameter received 15,000 r in air delivered to the lesion at one sitting. These patients visit the clinic today, they show no evidence of recurrence, a follow-up interval of six years. The fourth was given a much greater surface roentgen dose, as his lesion was larger and thicker. The theory is to deliver a carcinolethal dose to the base of the neoplasm estimating the absorption within the superficial layers of Paterson and Parker tables,[5] tumor dose being estimated to 6,000 gamma roentgens. Three of those treated by radium mold already had or later developed glandular extension. One of these cases with glandular extension was later controlled by the injection of interstitial radium and radon into the metastatic nodes (proved by biopsy to be carcinoma). This patient survived eleven years without further spread. The other 2 patients died nine months and one and a half years later. The remaining 7 cases are recorded as having satisfactory end results. When last seen they were without evidence of recurrence, from two to sixteen years.

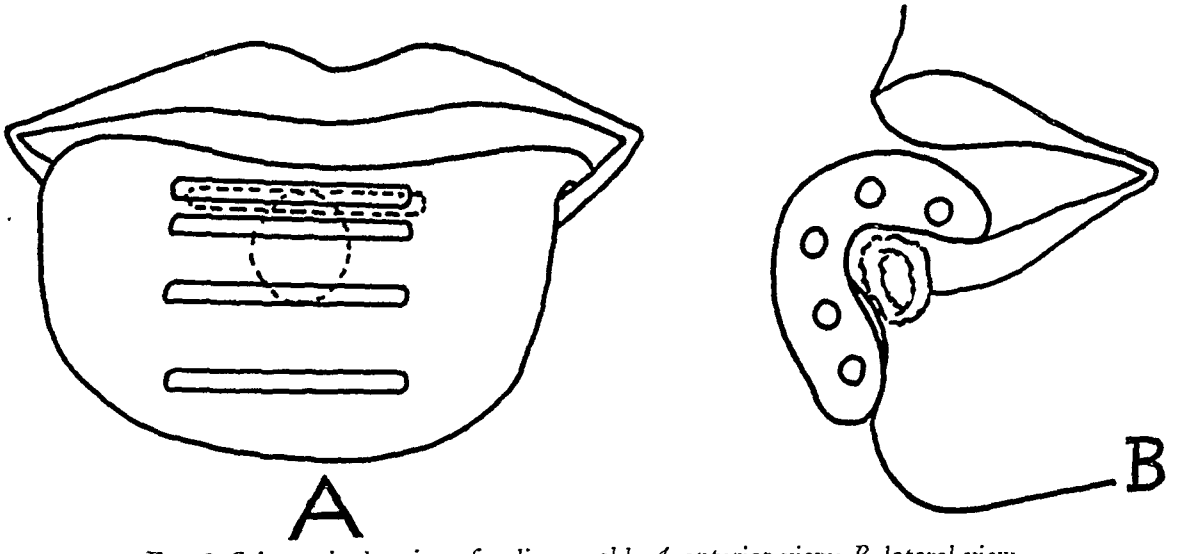


Fig. 8. Schematic drawing of radium mold. *A*, anterior view; *B*, lateral view.

the growth. This case developed cervical metastases which were treated by high voltage roentgen therapy augmented by interstitial radium. He died four years after the onset of treatment.

(C) Radium

(a) Mold: A radium mold was applied in 10 instances. By drawing the lip forward, the tubes can be arranged within a wax mold to crossfire the lesion both from the buccal mucosa and the external surface of the lip. The distance from the radium sources to the lip surface is 1 cm. (Fig. 8, *A* and *B*). The element tubes are filtered by 1 mm. of platinum. According to the extent of the lesion the total dose varied from 1,200 to 2,500 milligram-hours. Gamma roentgens have been computed since 1939, following knowledge and acceptance of

(b) Interstitial radium: Thirteen cases were treated by the insertion of radium needles or radon seeds in and about the lesion. When needles were used they were inserted from 0.5 to 1 cm. apart, often in two planes: one on the buccal, the other on the skin side (Fig. 9, *A* and *B*). The minimal gamma roentgen dose in all cases was calculated to 6,000 gamma roentgens. Not a single failure occurred in this group; all have survived a period averaging five to six years. Some still visit the clinic after a twelve years, others have been lost or have died from some intercurrent disease after several years of follow-up. Even though results of interstitial radium treatments in this small series were so uniformly satis-

factory, it must be admitted that dosage in gamma roentgens varies markedly in intensity within a few millimeters of the radium sources. Success, therefore, must depend on the ability of the operator to accurately place such focal sources of radiation within the tissues to avoid over and under dosage. Trauma relative to inserting needles or seeds into an infected area must also be taken into consideration when comparing with other modes of treatment.

(3) *Combined Procedures.* Treatment by combined procedures indicates that the first treatment choice was unsuccessful, and recurrence or residuum was treated differently. Failure of the original modality to control the growth and substitution of another method of treatment would obviously tend to lower the percentage of satisfactory end results. Twenty-four cases are recorded as treated by some combined method of therapy as follows:

(A) Surgery and roentgen therapy: Excision either followed or preceded by roentgen therapy is recorded in 6 instances. Five of these had a satisfactory end result though 2 were lost track of after two and five years respectively. One died of other causes after a seven year follow-up in the clinic. Two still attend the clinic, a time interval of seven and eight years respectively. The only one listed as a failure in this subgroup developed cervical metastases and died within nine months.

(B) Interstitial radium and surgery: Two patients were treated by combining interstitial radium with surgery. Here again the inference points to failure of the original effort with the second form of treatment serving as a stop gap measure. One of the 2 was lost track of one and a half years after completion of this treatment (a satisfactory result was noted on his record at his last clinic visit). The second listed as a failure developed cervical metastases early; he died within nine months.

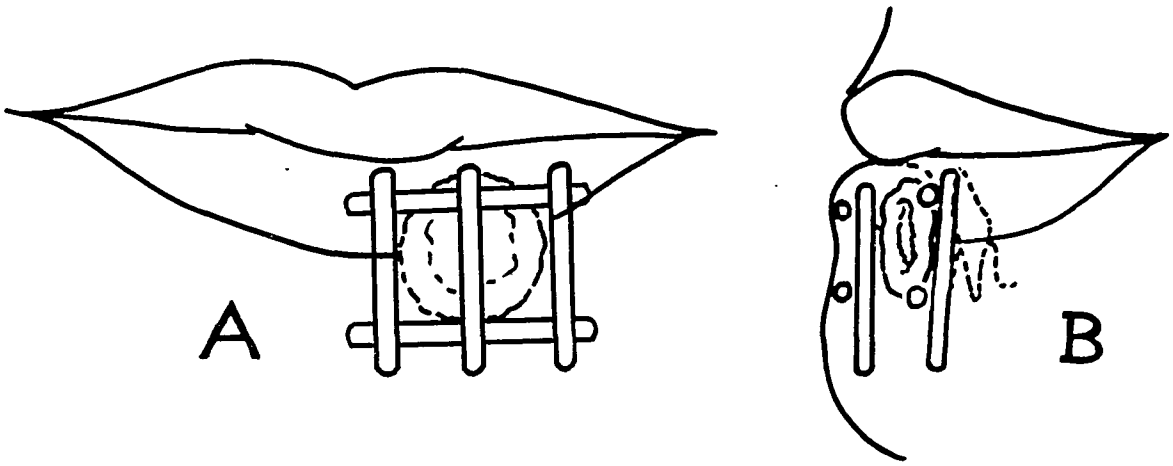


FIG. 9. Schematic drawing of arrangements of radium needles in interstitial treatment. Theoretically the central needle should be of lesser content. It is not always practical to insert needles both on the skin and mucous membrane sides of the lip. *A*, anterior view; *B*, lateral view.

(C) Surgery, roentgen irradiation and radium: One case only (treated in 1936) received roentgen therapy to a recurrence following surgery, and still later a small amount of radium was inserted into a further extension. In spite of the obvious fallacy in the conduct of treatment, this patient has been followed in the out-patient clinic for a period of nine years without evidence of further recurrence.

(D) Radium and roentgen therapy: Twelve cases were treated by combined radium and roentgen therapy. Many of these lesions were extensive when first seen, though the incomplete destruction of the lesion by the original method employed must be considered as a mitigating factor in the unsatisfactory end result obtained.

However, 5 of these 12 obtained a satisfactory end result with no recurrence or metastases appearing to date. Six (50 per cent) who developed cervical metastases and the seventh lost early to follow up are all listed as unsatisfactory. Since 1939 the more accurate estimation of dosage and the more extensive therapeutic attack have obviated the necessity of any second therapeutic approach. The percentage of lymph gland spread has also been proportionately reduced.

TREATMENT OF METASTASES

Carcinoma of the lip apparently spreads but slowly to the regional lymph glands. Less than 10 per cent were known to have cervical metastases on admission though the average duration of knowledge of the lip lesion averaged over one year. Destruction of the primary lip lesion proved sufficient to eradicate the disease in the majority of cases (78 per cent). These statistics indicate that prophylactic irradiation or surgical block dissection of the neck is hardly indicated as a routine procedure. Before 1937, 7 cases were given prophylactic irradiation to the neck. The total roentgen-ray dosage delivered by present day concepts was insufficient to destroy any metastases, if present. By the same token neck surgery other than a radical block dissection is unwarranted. Radical neck dissection even though it carries low morbidity and low mortality can hardly be justified as a routine procedure when metastases are shown to occur in but 1 in 7 instances.

Eight patients (males) when first admitted were known to have glandular extension either to the submental area, submaxillary triangle, or anterior cervical lymphatics. The only one to gain a satisfactory end result received roentgen therapy to the lip followed by radical block dissection of the neck. On his last visit to the clinic nine years after treatment, he appeared to be free of disease. All others are recorded as failures: 2 with metastases refused further treatment, dying one and two years later. All the others (5) received some form of radiation either alone or in combination to the metastases; all died from nine months to two years after institution of therapy.

As shown in Table 1, 21 cases (18 per cent) developed glandular metastases following therapy to the primary lip lesion. Only 4 of the 21 (19 per cent) obtained a satisfactory result: 2 by radical neck dissection and 2 by radon seed implantation. One of the 2 who survives following surgery has been followed for a period of ten years; the other died of intercurrent disease seven years later. The most successful method of handling cervical lymph node extension appears to be by radical block dissection.

Technique of radon seed implantation is as follows: Radon seeds each 1 mc., filtration 0.3 mm. of gold are as evenly distributed within the involved gland as possible. The plan is to distribute these radiant sources approximately 0.5 cm. apart. Such a seeded gland is estimated to receive up to 9,000 gamma roentgens. Of the 2 patients who survived seeding of metastatic neck glands one is still being followed in the clinic after eleven years, the other died of intercurrent disease seven years later. The remaining 17 are recorded as failures. All were treated by roentgen therapy, interstitial radon, singly or in combination. From an analysis of these results, external irradiation in doses sufficient to preserve the overlying skin is insufficient to sterilize such glandular extension. Roentgen therapy must therefore be supplemented by interstitial irradiation, this in order to deliver a sufficient cancerocidal dose.

Summary of all Cases (Table II). Individual end results are noted as died, lost, and—those still under observation—clinic. Treatment end results are listed as satisfactory or failure. To be listed as satisfactory, the patient must have been followed at least a year and a half in the clinic without evidence of recurrence or glandular spread. Certain cases who have died of intercurrent disease after years of follow-up

TABLE II

SUMMARY OF ALL CASES

Year	Case	Treatment to Lip	Treatment to Neck	History	Duration of Follow-up	Glands on Admission	Metastatic Spread	End Result	Treatment Result
1930	3220	Radium mold	No	6 mo.	2½ yr.	No	Yes	Died	Failure
	3384	Surgery	Roentgen therapy	1 yr.	6 mo.	No	Yes	Died	Failure
1931	3489	Roentgen therapy + Interstitial radium	No	3 yr.	2 yr.	No	No	Lost	Satisfactory
	3852	Roentgen therapy	Roentgen therapy	6 mo.	1½ yr.	No	No	Lost	Satisfactory
	3960	Radium mold	Roentgen therapy	1 yr. 3 mo.	1½ yr.	No	No	Lost	Satisfactory
	4003	Radium mold	Roentgen therapy	4 mo.	3 yr.	No	No	Lost	Satisfactory
	4024	Radium mold	Roentgen therapy	2 mo.	16 yr.	No	No	Clinic	Satisfactory
1932	4083	Radon mold	Roentgen therapy	1 yr.	9 mo.	Yes	Yes	Died	Failure
	5332	Surgery + Interstitial radium	No	3 wk.	1½ yr.	No	No	Lost	Satisfactory
	5508	Roentgen therapy	Roentgen therapy	2 mo.	1 yr.	No	No	Lost	Satisfactory
1933	6668	Roentgen therapy	No	3 mo.	2 yr.	No	No	Lost	Satisfactory
	6085	Roentgen therapy	Roentgen therapy	3 yr.	3 yr.	No	No	Died	Satisfactory
	6251	Radium mold	No	6 mo.	8 yr.	No	No	Died	Satisfactory
	6409	Roentgen therapy	Roentgen therapy	6 wk.	12 yr.	No	No	Died	Satisfactory
	5973	Interstitial radon	No	6 mo.	12 yr.	No	No	Clinic	Satisfactory
	5192	Interstitial radon + Roentgen therapy	No	8 mo.	9 yr.	No	No	Died	Satisfactory
	6475	Radium mold + Roentgen therapy	Roentgen therapy	1½ mo.	9 mo.	No	Yes	Lost	Failure
1934	6921	Roentgen therapy	No	2 mo.	13 yr.	No	No	Clinic	Satisfactory
	6704	Interstitial radon + Roentgen therapy	Roentgen therapy + Interstitial radon	2 mo.	3 yr.	No	Yes	Died	Failure
	6733	Roentgen therapy	Roentgen therapy	3 mo.	5 yr.	No	No	Lost	Satisfactory
1935	8123	Radium mold + Interstitial radon	No	1 yr.	7 yr.	No	No	Lost	Satisfactory
	8282	Interstitial radium	No	6 mo.	2 yr.	No	No	Died	Satisfactory
	7612	Interstitial radium + Roentgen therapy	Roentgen therapy	2 yr.	2 yr.	No	Yes	Died	Failure
	8304	Roentgen therapy + Interstitial radium	No	2 mo.	12 yr.	No	No	Clinic	Satisfactory
	8005	Roentgen therapy	No	7 mo.	5½ yr.	No	No	Lost	Satisfactory
1936	8443	Radon mold	Interstitial radon	4 mo.	11 yr.	No	Yes	Clinic	Satisfactory
	8359	Surgery + Interstitial radium + Roentgen therapy	No	3 mo.	9 yr.	No	No	Lost	Satisfactory
	8722	Surgery + Roentgen therapy	No	6 mo.	4 yr.	No	No	Lost	Satisfactory
	8759	Radium mold + Roentgen therapy	No	3 wk.	3 yr.	No	Yes	Lost	Failure
	8523	Interstitial radium	Roentgen therapy	20 yr.	7 yr.	No	No	Died	Satisfactory
	8421	Radium mold	No	4 mo.	4 yr.	No	No	Lost	Satisfactory
	8510	Surgery + Interstitial radium	Interstitial radium + Roentgen therapy	8 mo.	9 mo.	Yes	Yes	Died	Failure
	8447	Roentgen therapy	No	3 mo.	3 yr.	No	No	Lost	Satisfactory
	8888	Roentgen therapy	No	4 mo.	9 yr.	No	No	Clinic	Satisfactory
	8731	Interstitial radon + Roentgen therapy	No	1 mo.	11 yr.	No	No	Clinic	Satisfactory
	8770	Interstitial radium	No	1 yr.	10 yr.	No	No	Clinic	Satisfactory
	8725	Roentgen therapy	Roentgen therapy	8 mo.	3 yr.	No	No	Died	Satisfactory
	8749	Interstitial radon + Roentgen therapy	Interstitial radium + Roentgen therapy	3 mo.	2 yr.	Yes	Yes	Died	Failure
	8567	Interstitial radium	No	3 mo.	3 yr.	No	No	Died	Satisfactory
1937	595	Roentgen therapy	Surgery	1 yr.	10 yr.	No	Yes	Clinic	Satisfactory
	558	Roentgen therapy	No	1 yr.	7 yr.	No	No	Lost	Satisfactory
	325	Roentgen therapy	No	6 mo.	2 yr. 9 mo.	No	No	Lost	Satisfactory
	122	Roentgen therapy	No	6 mo.	9 yr.	No	No	Clinic	Satisfactory

TABLE II—(*continued*)

Year	Case	Treatment to Lip	Treatment to Neck	History	Duration of Follow-up	Glands on Admission	Metastatic Spread	End Result	Treatment Result
1937	546	Surgery + Roentgen therapy	No	16 mo.	7 yr.	No	No	Died	Satisfactory
	375	Interstitial radium + Roentgen therapy	Surgery	8 mo.	7 yr.	No	Yes	Died	Satisfactory
	2036	Radium mold	No	6 mo.	7 yr.	No	No	Lost	Satisfactory
	47	Roentgen therapy	Surgery	10 mo.	9 yr.	Yes	Yes	Clinic	Satisfactory
	398	Roentgen therapy	Interstitial radium	10 yr.	1½ yr.	No	Yes	Died	Failure
1938	945	Interstitial radium	No	8 mo.	6 yr.	No	No	Lost	Satisfactory
	674	Roentgen therapy	No	3½ yr.	8 yr.	No	No	Clinic	Satisfactory
	1112	Roentgen therapy	No	4 mo.	8 yr.	No	No	Clinic	Satisfactory
	861	Interstitial radium	No	18 mo.	9 yr.	No	No	Clinic	Satisfactory
	1352	Roentgen therapy	No	2 mo.	9 yr.	No	No	Clinic	Satisfactory
	1380	Surgery + Roentgen therapy	No	6 mo.	9 mo.	No	Yes	Died	Failure
	963	Interstitial radium	No	2 yr.	9 yr.	No	No	Clinic	Satisfactory
	1246	Interstitial radium + Roentgen therapy	No	5 wk.	2 yr.	Yes	Yes	Died	Failure
	831	Interstitial radium	No	1 yr.	5 yr.	No	No	Lost	Satisfactory
	907	Roentgen therapy	Interstitial radon	3 mo.	7 yr.	No	Yes	Died	Satisfactory
	1035	Interstitial radium + Roentgen therapy	No	6 mo.	1½ yr.	No	Yes	Died	Failure
	4357	Surgery	No	6 mo.	9 yr.	No	No	Clinic	Satisfactory
1939	2003	Roentgen therapy	No	10 wk.	8 yr.	No	No	Clinic	Satisfactory
	1773	Roentgen therapy	No	1 yr.	8 yr.	No	No	Clinic	Satisfactory
	1895	Radium mold	No	7 mo.	1 yr.	No	No	Lost	Satisfactory
	1912	Interstitial radium	No	3 yr.	2 yr.	No	No	Died	Satisfactory
	1922	Roentgen therapy	No	1½ wk.	2 yr.	No	No	Lost	Satisfactory
	1452	Surgery + Roentgen therapy	No	7½ yr.	8 yr.	No	No	Clinic	Satisfactory
	1741	Surgery + Roentgen therapy	No	3 mo.	2 yr.	No	No	Lost	Satisfactory
	1852	Roentgen therapy	Roentgen therapy	5 mo.	1½ yr.	No	Yes	Lost	Failure
	1850	Roentgen therapy	No	7 wk.	3 yr.	No	No	Died	Satisfactory
	1565	Roentgen therapy	No	6 mo.	7 yr.	No	No	Died	Satisfactory
	1648	Roentgen therapy	No	5 yr.	1½ yr.	No	No	Lost	Satisfactory
	1411	Roentgen therapy	No	6 mo.	8 yr.	No	No	Clinic	Satisfactory
	1940	Roentgen therapy	No	6 mo.	8 yr.	No	No	Clinic	Satisfactory
	1035	Interstitial radium + Roentgen therapy	No	6 mo.	1½ yr.	No	Yes	Died	Failure
	1742	Interstitial radium + Roentgen therapy	Interstitial radium + Roentgen therapy	4 mo.	1¼ yr.	No	Yes	Died	Failure
	1975	Interstitial radium	No	9 mo.	4 yr.	No	No	Lost	Satisfactory
1940	2629	Roentgen therapy	No	1 yr.	7 yr.	No	No	Clinic	Satisfactory
	2317	Roentgen therapy	Roentgen therapy	5 mo.	7 yr.	No	No	Clinic	Satisfactory
	2577	Roentgen therapy	No	2 mo.	7 yr.	No	No	Clinic	Satisfactory
	2308	Surgery + Roentgen therapy	No	1 yr.	7 yr.	No	No	Clinic	Satisfactory
	2651	Roentgen therapy	No	3 wk.	7 yr.	No	No	Clinic	Satisfactory
	2961	Roentgen therapy	No	6 mo.	7 yr.	No	No	Clinic	Satisfactory
	6197	Roentgen therapy	No	7 yr.	5 yr.	No	No	Lost	Satisfactory
	2774	Roentgen therapy	No	2 mo.	4 yr.	No	No	Lost	Satisfactory
	2966	Interstitial radium	No	1 mo.	7 yr.	No	No	Clinic	Satisfactory
	6647	Contact therapy	Interstitial radium + Roentgen therapy	10 mo.	4 yr.	No	Yes	Died	Failure
	4082	Roentgen therapy	Roentgen therapy	1 yr.	2 yr.	No	Yes	Lost	Failure
1941	3185	Roentgen therapy	No	5 mo.	6 yr.	No	No	Clinic	Satisfactory
	5613	Roentgen therapy	No	9 yr.	6 yr.	No	No	Clinic	Satisfactory
	3747	Contact therapy	No	2 yr.	6 yr.	No	No	Clinic	Satisfactory
	4096	Roentgen therapy	No	2 yr.	1 yr.	Yes	Yes	Lost	Failure
	4317	Contact therapy	No	1 yr.	6 yr.	No	No	Clinic	Satisfactory

TABLE II—(*continued*)

Year	Case	Treatment to Lip	Treatment to Neck	History	Duration of Follow-up	Glands on Admission	Metastatic Spread	End Result	Treatment Result
1941	3491	Contact therapy	No	3 yr.	6 yr.	No	No	Clinic	Satisfactory
	3385	Surgery	No	8 mo.	6 yr.	No	No	Clinic	Satisfactory
	3720	Surgery	No	6 mo.	6 yr.	No	No	Clinic	Satisfactory
1942	4233	Roentgen therapy	No	1 yr.	5 yr.	No	No	Clinic	Satisfactory
	5175	Surgery	No	8 mo.	5 yr.	No	No	Clinic	Satisfactory
	4281	Roentgen therapy	No	6 mo.	5 yr.	No	No	Clinic	Satisfactory
	4361	Surgery	No	2½ yr.	5 yr.	No	No	Clinic	Satisfactory
	5069	Roentgen therapy	Interstitial radium	2 mo.	1½ yr.	Yes	Yes	Died	Failure
	6005	Roentgen therapy	Roentgen therapy Radon seeds	1 yr.	1½ yr.	No	Yes	Died	Failure
	6221	Roentgen therapy	Roentgen therapy	1 yr.	2 yr.	Yes	Yes	Died	Failure
	4276	Roentgen therapy	No	6 mo.	5 yr.	No	No	Clinic	Satisfactory
1943	4800	Roentgen therapy	No	8 mo.	4 yr.	No	No	Clinic	Satisfactory
	4704	Roentgen therapy	No	6 mo.	4 yr.	No	No	Clinic	Satisfactory
	5018	Roentgen therapy	No	1 yr.	1 yr.	No	No	Died	Satisfactory
	6752	Roentgen therapy	No	6 mo.	2½ yr.	No	Yes	Died	Failure
	5798	Roentgen therapy	Interstitial radon Roentgen therapy	5 mo.	1½ yr.	Yes	Yes	Died	Failure
1944	7108	Interstitial radium	No	1 yr.	1½ yr.	No	No	Died	Satisfactory
	6864	Roentgen therapy	Roentgen therapy	1 yr.	9 mo.	No	Yes	Died	Failure
	6406	Roentgen therapy	Interstitial radon	3 mo.	1 yr.	Yes	Yes	Died	Failure
	5163	Roentgen therapy	No	4 mo.	3 yr.	No	No	Clinic	Satisfactory

but who have shown no evidence of recurrence in this interval are listed as satisfactory. Failure indicates inability to control the primary lesion or inability to destroy cervical metastases which may have appeared at any time during the follow-up period.

SUMMARY

In the fifteen year period, 1930 through 1944, 112 cases of proved carcinoma of the lip were admitted for treatment to the Brooklyn Cancer Institute.

A strong racial resistance was indicated by the absence of any lip lesion in Negro patients. A study of the histories failed to bring out any other evidence of hereditary influence.

The disease is almost entirely limited to the male and by inference it is suggested that the male hormone or some variant of this hormone may be the intrinsic etiological agent while the extrinsic factors can be many. Ultraviolet light is probably the most potent of these. Certainly smoking which is so frequently ascribed as a causative agent can be ruled out as so few lesions originate in the female though there has been a great increase in smoking among women in the last generation.

Differential diagnosis is not difficult and with modern methods of biopsy, dark field examination, and so forth, there should be little or no chance of error. The greatest danger lies in those cases where the carcinoma is limited to the depth of the lesion and thus missed in the biopsy speciman.

Accepted modalities of treatment are (1) surgery and (2) radiation. Radiation is subdivided into roentgen and radium therapy, each of which is again subdivided. End results obtained by all forms of treatment are reported.

In the treatment of cervical metastases, end results favor block dissection of the neck. External irradiation alone was shown to be insufficient to control such extension.

Eighty-six of 112 patients (77 per cent) are recorded as having a satisfactory end result, no case being omitted because of

extent of lesion. These individuals have been followed up for from two to sixteen years, averaging six plus years.

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SURGICAL AND RADIATION TREATMENT OF CANCER OF THE BREAST*

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IN RADIATION therapy, as otherwise in medicine, empiricism has played a great part in the indications for its use, as well as in the working out of methods. The empirical method has undoubtedly in many fields been the obvious and necessary one and has often been fruitful. This also applies to radiation therapy in cancer, the development of which must necessarily be based on experience. The statistical evaluation of the treatment results has then offered some clues to the desirability of altering the methods.

For malignant growths, however, there is the disadvantage in the procedure that a great many years are required for the collection of usable and comparable statistics, if this is at all possible. In the meantime our material, based on knowledge and experience, has gradually become so extensive as to offer a fairly good basis for a logical construction of treatment methods.

In cancer of the breast a number of conditions, for example varying demands on the diagnosis, variations in classification of the material, difference in technique of the surgical as well as of the radiation treatment, and the different composition of the materials, join in making the statistics for the treatment results a difficult basis for continued work. Only exceedingly extensive and highly uniform statistics should permit the drawing of definite conclusions. The best, quickest and most certain road to an adequate treatment would, therefore, in my opinion, be the development of technique and methods on the basis of theoretical reasonings, using the available materials from anatomical, histopathological, tumorbiological, radiobiological, clinical and physical examinations.

Making reservations for the shortcomings of the statistics, a review will here be given of the treatment results in cancer of the breast obtained at the Norwegian Radium Hospital, and according to a procedure that has been used here for a number of years. First, however, the logical foundation for our methods will be briefly considered.

When first taking up these problems for discussion (at the annual meeting of "Norsk Kirurgisk Forening" in 1937) I raised the following questions, an answer to which is necessary for an evaluation of the importance of radiation treatment in cancer of the breast:

1. Is roentgen or radium irradiation as a supplement to surgical treatment likely to improve the obtainable results?
2. Can radiation treatment replace surgical operation?
3. Will an energetic preoperative irradiation permit a less radical surgical intervention?
4. What doses will secure the best possible effect?
5. Should radiation treatment be given preoperatively or postoperatively, or preoperatively and postoperatively, and according to which technique? Should roentgen or radium irradiation be used?

To the answer to these questions we hold some clues of fundamental importance, namely first of all our experiences regarding the radiosentitivity of the mammary carcinomas. The results from some of our investigations in this field have been published.[1] In 92 cases, preoperatively irradiated with epidermicide doses, the degree of the irradiation effect was studied in connection with histopathological examinations after radical operation, three to eight

[1] Engelstad, R. B. On treatment of carcinoma mammae. Experiences from Norwegian Radium Hospital. *Acta chir. Scandinav.*, 1942, *87*, 545–572.

* From the Norwegian Radium Hospital, Oslo, Norway. Chief: Rolf Bull Engelstad, M.D.

weeks after the preoperative treatment (Table 1).

Table I

	Cases
Complete destruction of tumor	17
Strong irradiation effect	40
Moderate irradiation effect	20
No or inconsiderable irradiation effect	15
	92

Seven of the 17 cases with complete destruction of the tumor had beforehand been histopathologically examined. The clinical picture of the 10 remaining cases left hardly any doubt as to the diagnosis of cancer.

The radiosensitivity of mammary carcinomas thus shows great variations. A great many cases are very favorably influenced by irradiation, but there are also radioresistant forms.

Neither do the lymph nodes react alike to irradiation. It is our definite impression, however, that radiosensitivity of these structures is less than that of the mammary tumor proper.

Some years ago we made some unsuccessful attempts to find a definite relation between the histopathological structure and radiosensitivity of the growth. Whether a classification or grading as used by Geschickter will prove able to give certain clues has not been tried in the present material. The examination, however, is at present an item of the hospital program.

In fact, our observations on radiosensitivity of mammary carcinomas, showing fair agreement with those of other investigations, actually offer a rather good basis for the answer to the first four of our questions.

Ad. 1. Considering the marked radiosensitivity of more than half the number of examined cases, it seems reasonable to presume radiation treatment in addition to surgical operation to be capable of improving the results.

Ad. 2 and 3. On the other hand, the rather considerable number of mammary carcinomas with slight radiosensitivity makes a limitation of the treatment to irradiation or to local removal of tumor plus irradiation seem hardly justified. In this connection, however, the remarkable results obtained by the Englishmen Keynes and McWhirter after such procedure should be recalled. There is every reason to follow continued work in this field with the greatest interest. Particularly valuable would be the finding of a more suitable histopathological classification than the one used today. Because of our personal experiences we do not yet feel justified in reducing the demands on the radical operation.

We therefore still maintain the routine method of radical operation plus radiation treatment.

Ad. 4. For the size of the doses we are calling on the same experiences and the same reasonings. To obtain the best effect in the greatest number of cases, the doses applied should be as large as possible without causing serious radiation injury.

Ad. 5. To answer the last of the questions, some more factors than those mentioned above should be considered. The object of the radiotherapeutic procedures is not merely injury to or destruction of the tumor cells in the mammary region and in the adjacent regional lymphatics. Decisive for the fate of the patient is practically always the distant metastases. An effort to prevent these formations should therefore be our main task.

This may seem hopeless, and if metastasis essentially happened hematogenously, so it would be. The great majority of investigations, however, point to the lymphatics as the main route for the spread of cancer of the breast ("lymphatic permeation," Sampson Handley), at least during the comparatively early stages of the disease.

In operable cases the surgical treatment —with more or less certainty—is capable of controlling the primary tumor and some of the lymphatics, namely the axillary, and at least some of the infraclavicular ones. But the supraclavicular, some of the deep fascial and the lymphatics on the inside of the chest wall are inaccessible to radical surgical therapy. Destruction of tumor cells along these lymph routes is the most important task of radiation therapy.

The areas to be irradiated are therefore, besides the mammary region and the axilla, also the infraclavicular fossa, the supracla-

vicular fossa, the deep fascial and the intrathoracic lymphatics. Most important are probably the latter. For the most effective and homogeneous irradiation of these regions, the operative removal beforehand of the breast with the underlying musculature and other soft parts is an essential advantage. This appears most convincingly from some figures which I have included in some of my earlier works. In my opinion anatomical, radiophysical, tumor-biological and radiobiological reasons favor the belief that *radiation treatment for cancer of the breast should be given postoperatively in one treatment series and with large doses.*

The most important advantages of the procedure may be summed up as follows:

(a) Conditions are rendered favorable for an homogeneous irradiation with the largest possible doses.

(b) Access is rendered easier to the very lymphatics that most need the radiation treatment, and that are inaccessible to surgical operation.

(c) Needless delay is avoided of the radical operation of a tumor that possibly is only slightly radiosensitive, or even entirely radioresistant.

The postoperative treatment may be given in the form of roentgen or radium irradiation. The roentgen treatment is given over two tangential fields covering the area from the anterior midline to the posterior axillary line, from the clavicle toward the costal arch in the mid clavicular line, including the mammary region, axilla and infraclavicular fossa (175 kv., 4 ma., filter 1 mm. Cu, focal skin distance 50 cm.). Daily doses of 350 to 400 roentgens and total doses of about 3,500 r per field are given. A large thorax may need a supplementary radiation field between the two tangential ones. In addition, a supraclavicular field is always irradiated. In radium treatment, the thoracic field with axilla and infraclavicular fossa is irradiated using a mold at a radium skin distance of 3 cm., and greatly protracted (application period six to seven days). Teleradium is then used over the supraclavicular fossa. In radium treatment, daily doses of 500 to 600 gamma roentgens and total doses of 3,500 to 4,000 gamma roentgens are used.

Satisfactory radiation penetration of the thoracic wall and of the other regions concerned are obtainable by both methods. But radium treatment, which we prefer for most cases, may offer certain advantages, such as a favorable distribution of the depth doses and continuous irradiation with low intensity over a comparatively long period of time. However, postoperative radium treatment of all mammary carcinomas is not possible with the disposable quantities of radium. If only for this reason must roentgen treatment be extensively used.

For inoperable tumors, primary radiation treatment is given. If the tumor thus becomes operable, a radical operation is done and this is followed by postoperative irradiation.

Cancer of the male breast is treated according to the same principles: radical operation and postoperative radiation treatment.

It stands to reason that a special institute for radiation treatment of cancer will admit a great many patients with recurrence or metastases, and who have earlier been treated at other hospitals. Such cases are seen to constitute a rather considerable part of the present material.

Local recurrences, cutaneous or subcutaneous nodules are treated with radium on a mold or roentgen therapy, occasionally with contact roentgen therapy. Freedom from symptoms, lasting up to more than ten years, has been obtained in a few cases.

Lymph node recurrences are treated with teleradium or roentgen therapy. Also here freedom from symptoms lasting for years may be obtained in rare cases.

Roentgen irradiation is used for skeletal metastases, often with singularly good palliative effects, and sometimes with striking improvement of the roentgenological changes.

As a rule, pulmonary and other visceral metastatses are not given radiation treatment.

Some years ago we tried total roentgen irradiation according to the method of Mallet in some cases of mammary carcinoma where there was a generalized extension; with no expectations, however, from a method that can hardly be thought especially effective except for the most highly radiosensitive tumors. Neither was there any effect worth mentioning. Therefore we have in late years not been using total irradiation for general metastases from carcinoma of the breast.

Some of the difficulties connected with an evaluation of the statistics of the treatment results for carcinoma of the breast have already been mentioned. The difficulties are so considerable that a comparison of different statistics will often be of very little value. When even so I have considered the publication of the material from the Norwegian Radium Hospital to have some interest, this is, for one thing, because the material has gradually become so extensive that some of the sources of error are sufficiently reduced to justify this statistical study. It will, at any rate, give a certain impression of the value and the deficiencies of the treatment methods employed. An analysis of the material, collated with other experiences, might also be thought capable of rendering some support to our efforts to improve the treatment.

The first difficulty to be faced, when working on cancer of the breast material, is the classification of the stages. One has to remain satisfied with a rather rough classification, based on the simplest possible clinical and pathologic-anatomical conditions that are capable of one interpretation only. Nevertheless, the border lines will be blurred and the classification often uncertain.

For a number of years we have been using the following classification:*

Stage I: Operable cancer of the breast with no clinically or histopathologically demonstrable spread.

Stage II: Operable cancer of the breast with clinically or histopathologically demonstrable operable metastases to the axillary lymph nodes.

Stage III: Inoperable cancer of the breast or inoperable axillary or infraclavicular metastases, or supraclavicular metastases (operable or inoperable).

Stage IV: Distant metastases (or recurrences).

Besides the erroneous sources of the classification, attributable to the inevitable presence of transitions, the ever existing possibility of uncertainty, due to imperfection of our examination methods, must be considered. Not the least difficult is classification of the individual patient in Stages I and II; this may even be impossible, especially in a large and inhomogeneous material like the present one. For some purposes the two stages will, therefore, for practical reasons, be regarded as one group.

In spite of all shortcomings, I believe our classification to be sufficiently simple to be practically applicable. It gives three large main groups:

The operable cases—with or without spread to the adjacent regional lymph nodes (Stages I and II).

The inoperable cases—inoperable either because of conditions in the primary tumor proper or in the adjacent regional lymph nodes, or because metastases have reached the lymphatics of regions that because of their location are inaccessible to radical surgery. In these cases, however, the condition is in a larger sense still regional (Stage III).

The incurable cases—in which spread has progressed beyond the regional lymphatics, forming distant metastases (Stage IV). Also recurrences in patients, who have earlier been treated elsewhere have, for practical reasons, been included in this group, although they actually belong outside the frame of a systematic stage classification.

The material here presented covers all patients treated—or examined—for cancer of the breast at the Norwegian Radium Hospital during the years 1932–1942. A

* The *clinical* demonstration of lymph node metastases has only relation to the cases where primary radical operation is not performed, as it is, of course, also necessary to classify these cases at the beginning of the treatment. In all cases primarily operated upon, i.e., *all* the patients who have received postoperative irradiation, the classification in stages is based upon *histopathological* examination of the lymph nodes.

total of *1,384 patients* have been treated here during this period; only those are included who have been observed for at least five years. Table II shows grouping of the material according to sex, civil position and number of children.

TABLE II

		Cases	Per Cent
Male		9	0.6
Female		1,375	99.4
of whom:	unmarried	394	
	married	981	
	number of children unknown	181	
	0 children	126	
	1 child	159	
	2 children	169	
	3–5 children	259	
	6 children or more	103	

I am content to record this distribution, and merely to deduce that the most varied categories are found well represented in the material: married and unmarried, women childless or with several children. Some time ago I had a statistician study these conditions compared to those in the normal population. The result of this evaluation was difficult to judge, but cancer of the breast seemed somewhat more frequent in women with few children than in those with a large number. At the same time, the cancer frequency within the various professions was investigated, but no statistically significant variations could be shown from one group to another.

The distribution of the ages is seen in Table III.

TABLE III

Under 30 years	11
30–39 years	141
40–49 years	391
50–59 years	382
60–69 years	299
Over 70 years	160
	1,384

The great majority of cases is found in the three decades from forty to sixty-nine years, and as many as 56 per cent in the forties and fifties. About 10 per cent is found as early as in the thirties, whereas before the age of thirty years the condition is very rare. This age distribution, which is fairly well known, may serve to illustrate the great social importance of mammary carcinoma.

It is a common belief that cancer of the breast is most frequently found in fat women. The present material indicates no tendency in this direction (Table IV), but definite conclusions cannot be drawn, as there is no material that can be used for comparison.

TABLE IV

	Cases	Per Cent
Corpulent	265	19.0
Normal figure	862	62.4
Thin	257	18.6

The histories have been studied with a view to other information concerning the patients' physique and appearance, whether they have been strikingly feminine or more masculine types, but no usable clues have been found.

In Table V some information from the histories has been recorded.

TABLE V

	Cases
Earlier mastitis	36
Earlier adenofibrosis	37
Menstrual disturbances	41
Pregnancy, lactation	24
Trauma	50

As is seen, a history of mastitis, adenofibrosis, menstrual disturbance or trauma is not very frequent, at least not as frequent as to be considered of special importance in connection with the question of the etiology. The 24 cases occurring, or being shown, during pregnancy or lactation will be discussed at a later point.

Distribution of the material into the various stages (Table VI) will evidently not

TABLE VI

	Cases	Per Cent	
Stage I	278	20.1	55.8%
Stage II	494	35.7	
Stage III	182	13.1	
Stage IV	430	31.1	

be the same from a radiotherapeutic institute as from a general surgical department.

Stages I, II and III are seen to make up 68.9 per cent, Stages I and II, 55.8 per cent of the total material. As these groups are the most interesting to us, they will be especially discussed in the following.

The fact that as many as 31.1 per cent are found in Stage IV is in itself not surprising, considering that these patients can be treated radiologically only, and therefore are referred to us. In this group there are some patients with distant metastases—to the skeletal system, to the lungs and other internal organs. Of these the skeletal metastases are well suited for palliative roentgen treatment, whereas the others, as a rule, are intractable. There are some patients with recurrences (or metastases) after earlier treatment at other institutes. These are local recurrences, often readily influenced, and in which freedom from symptoms years long in duration is not rarely obtained, lymph node recurrences or metastases which can be influenced to some extent, and recurrences (or metastases) to the skeletal system, to the lungs and to other internal organs, with the possibilities for treatment described above.

Especially during the first years of the Hospital's activities was the number of advanced cases (Stages III and IV) comparatively very large. This condition has gradually become somewhat altered, partly because the lack of accommodation has made us refuse many hopeless cases. There is the possibility, however, that a different cause—namely, more attention on part of the patients and the physicians—is partly responsible for this change in late years in the direction of the earlier stages. This would be a result of the educational work that has been concentrated on cancer of the breast more than on any other form of the disease.

Up to 1934 inclusive there were more patients in Stage IV than in Stages I and II together, but conditions have steadily improved. In 1938 and 1939 the number of patients in Stage I alone about equalled that in Stage IV, and the following years have shown more patients in Stage I than in Stage IV. There is no chance of this change being the result of an altered evaluation of the stages on our part, as Stage IV is an absolutely clear cut and well defined group, which, in contrast to the other stages, allows no fluid transitions. Only cases showing recurrence or distant metastases are registered as Stage IV.

It might be of interest to find out whether the distribution to the different stages bears some relation to the age at which the disease occurs (Table VII).

TABLE VII

PERCENTAGE DISTRIBUTION TO STAGES

	I	II	III	IV
Under 30 years	45.5	45.5		9.0
30–39 years	17.0	42.6	8.5	39.9
40–49 years	22.3	37.6	11.3	28.8
50–59 years	19.9	33.7	13.4	33.0
60–69 years	17.4	35.8	13.7	33.1
Over 70 years	21.3	28.8	21.3	28.6

The number in the age group below thirty years is too small to be included. Stage II shows comparatively few cases from the oldest age group; that, on the other hand, is noticeably well represented in Stage III. Less attention on part of the aged may possibly be partly responsible for this. Stage IV has its greatest percentage contribution in the age group thirty to thirty-nine years, which possibly may have some connection with the often very rapid spread seen in young patients. On the other hand, many chance conditions will certainly make themselves especially felt in Stage IV.

Next the treatment methods employed will be considered (Table VIII).

Stages I and II are joined into one group, having been treated according to the same principles.

Radical operation followed by postoperative irradiation has been used in the great majority of cases in Stages I and II. The fairly extensive use of other methods, as

seen from Table VIII, is due partly to the deficient development of our present treatment methods during the first years of our activities, partly to the fact that we have not always been free in the choice of treatment; that has been decided by dispositions already made before the admission to the

TABLE VIII

	Stages I–II	Stage III	Stage IV
Non-radical operation	3	1	
Non-radical operation plus irradiation	41	10	4
Radical operation	3	2	1
Radical operation plus preoperative irradiation	36	23	
Radical operation plus pre- and postoperative irradiation	18	16	
Radical operation plus postoperative irradiation	609	61	10
Irradiation only	20	38	317
No or incomplete treatment	42	31	98

Norwegian Radium Hospital. In Stage III are seen a number of cases of amputation of the breast with axillary dissection. These are partly inoperable tumors that have become operable subsequent to radiation treatment, partly supraclavicular metastases where these have been thought capable of being controlled by irradiation, and partly where the method has been thought capable of giving the best possible palliative effect and prolongation of life. The latter arguments also apply to most patients in Stage IV in whom radical operation has been done in spite of the presence of distant metastases.

The postoperative control examinations of these patients have, in the great majority of cases, been made by ourselves, where difficulties of geographical or other nature have not been too great. In the latter and in a few other cases the control examination has been made at the hospital of the patient's home district, where she has usually also been operated on, or by the patient's own physician. Observation of the patient has, as a rule, been continued beyond the usual period of five years. In every case contact with the patient has been kept up by some means.

This control system has proved very effective. Of the 1,384 cases only 7 patients have been lost track of.

Six hundred and ninety-eight patients have an observation period of ten years (Table IX).

TABLE IX

	Total		Symptom Free		Per Cent	
Stage I	100	330	59	138	59.0	41.8
Stage II	230		79		34.4	
Stage III	91		3		3.3	
Stage IV	277		8		2.9	

Table IX does not require extensive comments. It shows a ten year symptom-free period in 41.8 per cent of the cases in Stages I and II together. Some patients who have died from intercurrent disease and without signs of recurrence of the cancer have not been included, so that the correct percentage of recoveries actually is somewhat higher.

The nearly 3 per cent of symptom-free cases in Stage IV may seem surprising. All of these patients, however, have been treated for local recurrence. In no case with distant metastases has ten years, or even five years, of freedom from symptoms been obtained.

The mammary cancer was bilateral in 44 patients, in most cases with a shorter or longer interval of time between manifestation of the cancer in the two breasts. Of these there were 8, that is 18.6 per cent, symptom free after ten years.

No patient in the present material has been observed for less than five years, and the results will be studied somewhat more closely. A review of the results after five years of observation is found in Table X.

The four stages seen collectively show 520 of 1,377 cases to be symptom free after five years, that is *37.8 per cent.* There is no

Table X

	Total	Symptom Free 5 Years	Per Cent
Stage I	274	220	80.3
Stage II	494	261	52.8
Stage III	181	17	9.4
Stage IV	428	22	5.1

reason, however, why patients belonging in Stage IV should be included in this general review, partly because the condition in these patients has become generalized, partly because they have been treated elsewhere at some earlier point of time, and have come to the Radium Hospital with recurrences to receive palliative treatment, or merely because they have wished something to be done. It is remarkable nevertheless that five years of freedom from symptoms has been obtained in 5.1 per cent of these hopeless cases. The great majority of these is made up from patients with local recurrence; in a few cases there are lymph node recurrences in the axilla or supraclavicular fossa.

tion will be given of the five year results for the total material (Table XI).

In view of the fact that many patients in the present material are of an advanced age, it stands to reason that some have died from intercurrent disease in course of the observation time. A really correct picture of the value of the treatment methods applied would require a correction for the symptom-free patients who have died from intercurrent disease. In some cases, however, an estimation may be difficult or information unsatisfactory, and I have therefore desisted from correcting the results to a calculated freedom from symptoms, and shall merely state that the percentage numbers recorded undoubtedly are somewhat low.

The presence in the five year material of 65 cases (47 per cent) in the different stages of *bilateral* manifestations should also be mentioned. Twenty-one of these, or *32.3 per cent, are symptom free.*

In Table XII are seen the results after five years of observation for Stages I and II collectively. The material consists of 768 patients.

Table XI

	Stage I	Stage II	Stage III	Stage IV
Symptom free	220 (80.3%)	261 (52.8%)	17 (9.4%)	22 (5.1%)
Symptom free, died from intercurrent disease	20	38	8	5
Alive with recurrence	1	13	6	15
Died from breast cancer	33	182	150	386

Study of the total result for Stages I, II and III gives 498 symptom-free cases after five years of observation in a material of 949 patients, that is *52.5 per cent* of operable and inoperable cases. Most interest, however, centers on Stages I and II, the operable cases, because only here can one speak of a radical radiological-surgical treatment, and because only these two stages are capable of offering comparable statistics.

Before proceeding in our study of Stages I and II, however, more accurate informa-

The present material, in comparison with the one which I published in 1942, shows further improvement. In 1942 there

Table XII

	Number	Per Cent
Symptom free	481	62.6
Symptom free, died from intercurrent disease	58	7.6
Alive with recurrence	14	1.8
Died from breast cancer	215	28.0

was freedom from symptoms after five years in 77.4 per cent of the cases in Stage I, in 46.8 per cent in Stage II, and for stages I and II collectively the result was 54.4 per cent. Possibly the larger numbers, and therefore the more reliable statistics may be held partly responsible for the apparent improvement. It should be permissible, however, to think that the continued development and systematizing of the treatment methods has also played a part.

To find out whether age is of any importance in the prognosis, in Table XIII the results for Stages I and II have been arranged according to age.

TABLE XIII

Age	Total	Symptom Free	Per Cent
Under 30 years	10	5	50.0
30–39 years	84	53	63.1
40–49 years	234	171	73.1
50–59 years	203	117	57.6
60–69 years	157	90	57.3
Over 70 years	80	45	56.2

The age group under thirty years shows the lowest percentage number of symptom-free cases; however, the number is too small for conclusions to be drawn. The result for the group thirty to thirty-nine years is more favorable than for any group over fifty years, but poorer than for the group forty to forty-nine years; this ranks highest of all with 73.1 per cent. Therefore the material does not indicate a particularly bad prognosis for the relatively young. On the contrary, the results are apparently poorest in the older ages.

The results should also be studied in relation to the different treatment methods employed. This comparison must be limited to Stages I and II, the smaller groups being left out (Table XIV).

The highest percentage of symptom-free cases is found among the postoperatively irradiated cases, whereas the two other groups are too small to justify a comparison.

The routine treatment method at the Norwegian Radium Hospital, namely teleradium treatment of the supraclavicular fossa and radium on a mold over the mammary field with axilla and infraclavicular fossa, has already been given. In Table XV these patients have been separated from those treated with roentgen therapy, and also the ones operated on and postoperatively treated at the Norwegian Radium Hospital have been placed in a separate group. In the present material this latter group is still very small, but it has grown considerably in the following years. However, as yet the observation time is too short.

TABLE XIV

	Total	Symptom Free	Per Cent
Radical operation plus preoperative irradiation	36	20	55.6
Radical operation plus pre- and postoperative irradiation	18	12	66.7
Radical operation plus postoperative irradiation	609	420	69.0

TABLE XV

POSTOPERATIVELY TREATED, STAGES I AND II

	Total	Symptom Free	Per Cent
Norwegian Radium Hospital routine method	448	320	71.4
Operated and postoperatively irradiated at Norwegian Radium Hospital	22	19	86.4
Roentgen treated	139	73	52.5

Of the 22 patients, operated upon and postoperatively treated at the Norwegian Radium Hospital, 19 (86.4 per cent) are symptom free after five years. As mentioned, however, the number is too small to be statistically significant. But also our impressions in late years tell of somewhat more favorable results in these cases. I have no intention to suggest that this, if true, would be attributable to our surgical tech-

nique. But the early institution in these conditions of postoperative radiation treatment, four to five days after the operation, may play some part. And there is good reason for assuming this to be an important point.

Table xv further shows better results to be obtained after our postoperative radium treatment than after roentgen irradiation. Not attaching too much importance to these figures, I still believe them to be the expression of a certain real difference. It should be mentioned in this connection that the radium-treated patients are, by no means, a selection of favorable cases. The amount of radium at our disposal at the hospital is not sufficient for radium on a mold for all patients who need it, and roentgen irradiation has therefore to be used for some. The rule is, then, that patients in Stage II are given priority in treatment with radium, as in these cases the treatment is considered most urgently needed. When there is not enough radium for all, roentgen treatment is therefore first of all given to patients in Stage I.

As mentioned above, a rather extensive use of roentgen radiation for postoperative treatment is unavoidable. The quantities of radium required for treatment of all cases would far exceed the amount in this country today. Too much importance must naturally not be attributed to the figures given here. When evaluating the treatment results for cancer of the breast the erroneous sources are many and incalculable.

The question must now be asked: Is there any good reason why radium treatment should give better results than roentgen irradiation, considering that the biological effects of the two kinds of rays are identical? The answer will be that, at least with the methods used today, the conditions for radium treatment are possibly more favorable. The distribution of depth doses is very helpful, and—what is possibly even more important—continuous irradiation with radium, with low intensity over a period of six to seven days may, according to the present knowledge of the importance of the time factor to the biological radiation effect, well be thought to yield somewhat more than the fractionated or protracted-fractionated roentgen irradiation.

It would, in my opinion, be a mistake to neglect the indicated difference in treatment results of the two forms of postoperative irradiation. The consequence of this must be an attempt to modify the technique of roentgen irradiation so that this will approach as nearly as practically possible the conditions of radium treatment. For this purpose we have tried partly a reduction of the radiation intensity, but first and foremost a more fractionated irradiation, with two daily seances, permitting a somewhat larger daily dose. As soon as the results had become clear to us, we changed the postoperative roentgen treatment of cancer of the breast at the Norwegian Radium Hospital, in an effort thus to improve the results.

Before leaving the statistical discussion of our material, a special group of mammary cancers, namely those occurring in connection with pregnancy or lactation, should be mentioned. It is probably a general experience that cancer of the breast in these conditions is particularly malignant, possibly because of the change in hormonal conditions. The considerable difficulty of recognizing a tumor in a lactating breast may be partly responsible. It is important in these cases that the breast should be emptied of milk before the examination. By this means an otherwise impalpable tumor may be felt.

The present material includes 24 cases of cancer of the breast during pregnancy and lactation. The distribution to the different stages and the results after five years of observation are seen in Table xvi.

Earlier our impression has been that the prognosis in these cases was hopeless, but this is apparently wrong. A decisive factor heretofore has possibly been the often late institution of treatment in these cases because of the diagnostic difficulties. Making reservation for the small number in this part of the material, the chances for recovery in the early stages (Stages I and II) do not seem essentially different from what

is to be expected in the other forms of the disease. In any case, it should be permissible to regard the prognosis as not hopeless.

During the period covering this material no other method than operation and radiation treatment has been used by us to any extent worth mentioning. We have thus only lately and to very small extent

TABLE XVI

	Total	Symptom Free	Per Cent
Stage I	4	4	
Stage II	9	6	
Stage III	2	0	
Stage IV	9	0	
All stages	24	10	41.6

tried the effect of hormones on mammary cancer.

Preclimateric castration of patients with cancer of the breast has for a long time had its adherents. This has been based partly on animal experiments (Lacassagne *et al.*), partly on experience of the greater malignancy of mammary cancer during pregnancy and lactation. Formerly we have very rarely used this method, and then only for otherwise intractable metastases or recurrences. We have not earlier used castration as part of the routine treatment. The most marked effect observed up to now, as far as I have been able to find out, has been limited chiefly to cases with distant metastases, especially to the bony skeleton. Although animal experiments may have proved castration at a young age capable of preventing mammary cancer, this does not mean that castration at an advanced age would have the same effect on the fully developed cancer. The value of castration as part of the routine combined treatment of cancer of the breast has not been convincing. It is therefore natural that a treatment so strongly affecting the lives of women will be regarded with some reserve.

Lately, however, another method has been added, necessitating a revision of this view, namely the experiences of the effect of the androgenous hormone. Up to now the method has been tried here in no more than 11 cases, with daily injections of 100 mg. of testosterone propionate (Testin Nyco) up to total doses of 2,500–4,000 mg. Our material consists of 3 patients with local recurrence, and with convincing result in no case; 4 patients with metastases to the spine, with some relief from pain in 2, but with objective improvement in none; and 3 patients with metastases to the lungs, showing distinct reduction of the metastases in one, no change in the second, and continued progression in the third, and finally one patient with supraclavicular lymph node recurrence in whom questionable temporary improvement was seen. At present we have some other patients receiving the treatment, but it is too early to judge the effect.

Our personal results are thus very modest, but some cases have been recorded (among others by Adair and Prudente), one has also been demonstrated to me, in which striking effect had been obtained, even if merely temporary. It can therefore hardly be doubted that treatment with the androgenous hormone in large doses *may* have some influence on the condition, at least on some of its manifestations.

Collating all experimental and clinical observations, it seems most probable that the sexual hormones play some, possibly a great part in the occurrence and further development of mammary cancer, and that the influence on the hormonal balance may be used therapeutically.

We have therefore thought it appropriate to make these problems a subject of investigation. At present the work is pending in collaboration with Knud Nicolaysen, Jens Bjørneboe and Per Laland. The procedure today at the Norwegian Radium Hospital is the following:

For Stage I the usual radiation and surgical treatment is used, as a rule not in connection with any form of hormonal therapy.

Also for Stage II the radiation and surgi-

cal treatment is unchanged, but here it is combined with ovarian roentgen irradiation with doses of 1,200–1,500 roentgens (measured on the skin) over each of two (or three) fields, followed by testosterone propionate 100 mg., three times a week for ten weeks. During the treatment period the urine is regularly examined for androgenous hormone.

For Stage III the same combined radiation and surgical treatment is given as before, adapted to the special conditions of the individual case, and in addition the ovaries are irradiated and testosterone propionate injections given in some cases.

Stage IV is usually treated with irradiation over the ovaries and possibly with testosterone. Roentgen irradiation is used as before for skeletal metastases, and roentgen or radium treatment for local recurrences, as for recurrences or metastases to lymph nodes, whereas metastases to the lungs and other visceral organs, as before, are given local irradiation in exceptional cases only.

The doses used for irradiation of the ovaries are considerably larger than the usual roentgen castration doses. It has lately been claimed by several authors that producing menopause is not enough. It is believed that a stronger influence on the ovarian hormone production is required. For the same reason irradiation of the ovaries is used also after the climacterium. Otherwise there are no clues to the determination of the optimal roentgen dose for the ovaries; possibly they should be even larger than those used today.

The development of a severe and stubborn leukopenia sometimes makes the combination of postoperative radiation treatment and irradiation of the ovaries difficult to accomplish. Therefore the advantage of an operative castration may be considered. Temporarily we are trying to gain the point by reducing the size of the fields for ovarian irradiation as much as possible, in every case marking off projection of the ovaries on the abdomen and on the back.

It is still too early to form an opinion of the possibility for making use of the discoveries in late years in the field of atomic physics in the treatment of cancer of the breast. This applies to neutrons, positrons and fast electrons alike. The latter might be thought capable of offering certain advantages, if they can be emitted from the apparatus in sufficient amounts and in a wide enough beam. Neither is applicability of the radioactive isotopes very well known. Were isotopes with long half-life period and with sufficient intensity of the gamma rays available, these might perhaps enable a more extensive use of postoperative radiation treatment, according to the method that has for a long time been used at the Norwegian Radium Hospital. Another question, and still more important, is what can be obtained by an internal selective irradiation, that is the peroral or parenteral use of isotopes with short radiation period and with special affinities, conditioning a deposition in the tumor cells or in the tumor-infiltrated organs and tissues.

Finally, it should be mentioned that in cancer of the breast attempts have been made to use the radioactive isotopes for diagnostic purposes, here also taking advantage of a special affinitity for the tumor cells.

A sound scientific evaluation of the various new methods that are being or will be tried in the years to come, will probably require a number of years. Although it might be permissible to expect great results from some of these methods, there is no reason today why our present irradiation and surgical methods should not be continued. The development in recent years of the combined radiation and surgical treatment has been seen to bring about a noticeable improvement in the results. Continued development in this field, combined with the efforts to enable an early diagnosis, will undoubtedly lead to further improvement of the results for this exceedingly important form of cancer.

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COMPLICATIONS FOLLOWING THE USE OF LOW INTENSITY, LONG RADIUM ELEMENT NEEDLES IN THE TREATMENT OF CANCER OF THE CERVIX UTERI*

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IN SEVERAL articles published since 1930[5,6,11,12] we have described and illustrated a method of treating cancer of the cervix with long element needles. Survival rates both five and ten years have been given and complications reported briefly. It is the intention in this paper to discuss complications in more detail in order to dispel certain naturally occurring fears as to the propriety of placing these long needles deep into the pelvic structures. Severe infections, peritonitis, parametritis, frequent fistula formations, injuries to bladder, ureters and intestines have been foreseen and warned against. That this has not been our experience, as we hope to show, we attribute to the type of needle used and to the wide distribution of these weak sources by which we have attained a more uniform irradiation of high total dosage.

A study of the natural course of carcinoma of the cervix reveals that its spread into the pelvic structures is by two routes (Fig. 1): (1) primarily by direct infiltration into the paracervical and parametrial

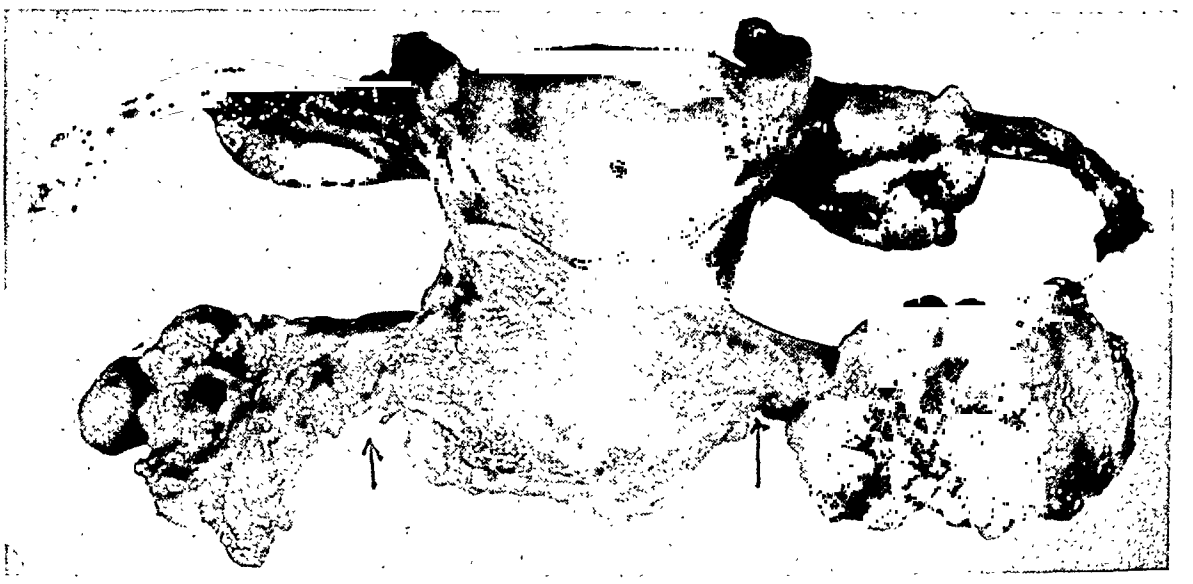


FIG. 1. This photograph of the authors' hysterectomy specimen is shown to illustrate the mechanism by which ureteral obstruction occurs. Note direct invasion of parametrium from the cervix and secondary invasion or growing-in of carcinoma from hypogastric and obturator nodes. Most ureteral obstructions are the result of carcinomatous invasion and are not of radiation origin. Specimen was removed from patient whose cervical cancer had been treated transvaginally with roentgen irradiation with superficial healing.

* From the Tumor Clinic, Rhode Island Hospital, Gynecological Service, Providence, Rhode Island. Presented at the Forty-eighth Annual Meeting, American Roentgen Ray Society, Atlantic City, N. J., Sept. 16–19, 1947.

structures and adjacent viscera, (2) secondarily by lymphatic metastasis to pelvic nodes followed by invasion beyond their walls into surrounding tissue spaces with final growing back towards the cervix and complete parametrial fixation when the outward and inward masses join. The ureters may be caught in either form of extension. Their walls may be invaded and narrowed, and obstruction occur. The bladder base is invaded anteriorly and the rectum posteriorly. When, by the natural course of the disease, ulceration occurs with necrosis and crater formation, fistula is the natural termination. When cancer of the cervix in the more advanced forms is treated with radium, it is often difficult to say whether the fistulous complication or ureteral obstruction occurred as the result of the disease or the radium treatment. It is really only in the early case where the fistula comes immediately following treatment and where the cancer is controlled that responsibility can be justly determined. The injuries caused by radium and roentgen rays through their destructive action on the normal tissues have been well described in the literature[1,2,3,7,8,9] and need no further elaboration in this paper.

MATERIAL FOR STUDY

This study is based on the clinical records of 621 patients seen and examined at the Tumor Clinic of the Rhode Island Hospital 1926–1941. Of this number 95 were too advanced to treat, received their initial treatment elsewhere, or were treated with roentgen radiation for palliation only. Thirty-seven were treated by other methods than needles, leaving a total of 489 cases where needles were used as the primary planned treatment, 77 per cent of all the cases. (Many of the cases not treated with needles came in the earlier years when we were experimenting and had not yet adopted the needles as routine.)

TABLE I

Year	Stage	Needles	Roentgen Treatment	Time	Cause of death
1927	III	+	0	9 days	Embolism
1928	III	+	0	14 days	Nephrosis toxic (autopsy)
1928	IV	+	0	25 days	Hemorrhage
1930	IV	+	0	30 min.	Collapse—after anesthesia
1931	III	+	0	32 days	Sepsis—thrombophlebitis
1931	IV	+	+	21 days	Pyelonephritis (autopsy)
1932	III	+	0	16 days	Pyelitis—peritonitis
1932	IV	+	0	3 days	Embolism
1935	III	+	0	33 days	Peritonitis
1936	III	0	+	30 days	Pyelitis—*B. coli*
1937	III	+	+	22 days	Hemorrhage
1937	IV	+	+	14 days	Pelvic cellulitis; peritonitis

FOLLOW-UP

As our follow-up through our secretary and social worker has been very efficient and as practically all our patients are Rhode Island residents—a small state—we feel that our records are quite complete with only 2 cases lost (a follow-up of 99.7 per cent).

COMPLICATIONS

The following complications have been selected for discussion: (1) immediate mortality; (2) fistula formation; (3) urinary complications; (4) intestinal complications; (5) severe inflammatory reactions.

Immediate Mortality. By immediate mortality we mean death occurring during hospital stay following treatment (Table 1).

A review of these deaths shows a gross mortality for the 621 cases absolute of 12 of 621, or 2 per cent, or for the cases treated with radium needles, 11 out of 489, or 2.2 per cent. All of these deaths were in advanced cases in anemic, debilitated, and often septic states. All occurred before 1938. The 2 deaths due to embolism certainly are not directly attributable to the method. The 2 deaths from hemorrhage might conceivably be but as they both occurred some time after the radium needles were removed, it is doubtful that the needles were the cause. The 1 postanesthesia collapse death is not due to the needles. Three cases of death from kidney sepsis or nephrosis surely represent poor preoperative study and preparation rather than a fault of the needles. The 3 cases of peritonitis or cellulitis resulting in death (0.6 per cent of treated cases) occurred before we had any sulfa drugs or antibiotics for combatting such conditions. The fact that we have had no immediate mortality from 1937 through 1946, except 1 case of embolism who died on the ninth day, in 394 cases treated would seem to indicate that needles are not directly responsible or should not be responsible for immediate mortality if cases are carefully studied as to blood status and kidney function, with intravenous pyelography, etc., and if possible sources of sepsis are cleared up either by preliminary roentgen therapy or by use of the sulfa drugs and penicillin before treatment.

TABLE II

SUMMARY

Embolism	2
Toxic nephrosis	1
Hemorrhage	2
Collapse	1
Sepsis thrombophlebitis	1
Sepsis pyelitis or pyelonephritis	2
Peritonitis or cellulitis	3:489 or 0.6%

Fistula Formation. Breakdown of tissues in the vaginal tract resulting in fistulous openings into the bladder, rectum, and small intestine can occur as the result of over-irradiation. They also occur spontaneously, as has been pointed out, during the later or more advanced stages of the disease where the cancer is uncontrolled by treatment. It is difficult, therefore, to place the blame for the fistula occurring late or as a terminal condition where active cancer is present. Fistulas are sometimes present before treatment or in the group having initial treatment elsewhere. Also it would seem that we should distinguish between the fistula occurring after primary treatment and that occurring after re-treatment. A high percentage of fistulas occurring after primary planned treatment would certainly be a serious objection to any method whereas one should expect a certain greater morbidity after re-treatment for uncontrolled cancer by any method. Table III gives the fistula incidence.

TABLE III

CASES OF FISTULA

1926–1941		621 cases (absolute)
Total number of fistulas—		56 (9.0%)
Present on admission	6	
Initial treatment elsewhere	8	
Treated primarily at Rhode Island Hospital		42
Total cases treated (all methods)		549
Fistula—all methods		42 (7.7%)
Treated with needles—primarily		489
Fistulas in primarily needle treated cases		40 (8.2%)

In order to show the time relation of the fistulas, whether after primary planned treatment, or after re-treatment, Table IV is presented.

Where radium needles alone were used as the primary treatment in 258 cases, no fistulas occurred in Stages I and II and for all stages the incidence was 3.1 per cent. Of the 77 re-treated cases, 8, or 10.4 per cent, developed fistulas, showing the increased liability to such damage following re-treatment. There seems to be a decided increase in fistula incidence when a combination of interstitial needles and external roentgen irradiation is used, the incidence rising from 3.1 per cent to 6.1 per cent in the primary group and from 10.4 per cent to 18.5 per cent in the re-treated group.

This study seems to confirm our impression of many years that external roentgen irradiation must be used with caution where interstitial radium treatment is contemplated.

One ileovaginal fistula occurred in a stump case. The patient died of peritonitis following an operation for repair of the fistula. Another ileovaginal fistula not shown in Table v occurred in a patient who had had a complete vaginal hysterectomy elsewhere for cancer of the cervix, was re-treated for recurrence with needles, developed an ileovaginal fistula which was

TABLE IV

FISTULA FORMATION

(A) Primary treatment—Radium Needles Alone 1926–1941

	No. of Cases	Fistulas	No. of Cases Re-treated	Fistulas
Stage I	18	0—0	3	0 0
Stage II	96	0—0	31	3—9.7%
Stage III	107	5—4.7%	37	5—13.5%
Stage IV	37	3—8.1%	6	0—0
Totals	258	8—3.1%	77	8—10.4%

(B) Primary treatment—Radium Needles plus Roentgen Therapy

Stage I	4	0—0	0	0—0
Stage II	65	5—7.7%	12	2—16%
Stage III	125	5—4.0%	35	5—14%
Stage IV	37	4—10.8%	7	3—43%
Totals	231	14— 6.1%	54	10—18.5%
Grand Total	489	224—.5%	131	18—13.7%

successfully closed by intestinal resection and anastomosis. The vesico-utero-colic fistula occurred in a patient who had a large growth invading the fundus. A departure from the usual technique in that a 50 mg. capsule filtered by 0.5 mm. of silver and 1 mm. of brass was placed in the fundus and by some mistake left in place forty-two hours instead of twenty-four hours resulted

TABLE V

TYPES OF FISTULAS ENCOUNTERED—489 CASES

Vesicovaginal	16—3.2%
Rectovaginal	11—2.2%
Both vesicovaginal and rectovaginal	11—2.2%
Ileovaginal fistula	1 stump case
*Ileovaginal fistula—primary vaginal hysterectomy elsewhere vaginal vault recurrence	1
Vesico-utero-colic	1
Total	40

* Not included in total; re-treated case—after surgery for cancer elsewhere.

in a massive breakdown of the fundus with fistula from colon to bladder.

Table VI shows the outcome of 40 cases treated with radium needles developing fistulas.

TABLE VI

Died with fistula—cancer uncontrolled	21
Closed spontaneously	6
Closed surgically	5
Died following repair	4
Living with fistulas 5 yr. or more	4
Total	40

Urinary Complications—Not Fistulas. Irradiation changes based essentially on an endarteritis or sclerosis resulting in ischemic edema and fibrous replacement or, if severe, in necrosis occur in varying degrees. The early or first degree injury results in some dysuria and frequency, often with mild hematuria. On cystoscopy after a few months the mucosa appears pale and shiny with loss of mucosal markings. Numerous small telangiectatic vessels and an occasional small ulceration appear. This lesion is often non-progressive although attacks of hematuria may recur over many years. We have 7 such cases on record. It is interesting to note that this lesion appeared most often in the Stages I and II and usually (5 of 7 cases) where extensive roentgen irradiation was used. A more severe reaction with actual ulceration, a sort of second degree lesion, is also observed. Here the findings are those of extensive bullous edema with

ulceration and incrustation, and occasionally stone formation, often leading to an erroneous diagnosis of cancer. These are serious lesions, are apt to bleed dangerously and the hemorrhage is difficult to control. In 1 of our 4 cases in our earlier experience, we were led by gross appearance to implant further radium needles intravesically. When the pathological report reached us several days later, the radium was withdrawn. After considerable suffering and many hospitalizations, this patient is still alive and without cancer, but with her right kidney removed and a nephrostomy tube in her left kidney. It will be eighteen years since her original treatment. A cystectomy and transplantation of ureters was necessary to control bleeding in another case. A patient with a lesser degree of ulceration survives nine years with only an occasional slight hematuria. A fourth case died of extensive pelvic spread of cancer. It is questionable if her lesion was irradiation reaction or was due to carcinomatous invasion.

Obstruction of the ureters due to irradiation and not cancer has occurred in this series in 8 cases. In deciding whether the ureteral stenosis was due to irradiation and not cancer we have had some difficulties: for example, in 1 case the patient, a large Stage II adenocarcinoma with pyometra developed a left hydronephrosis about three months following treatment, the hydronephrosis being demonstrated by an intravenous pyelogram. She had been treated with needles plus roentgen irradiation externally. As no preliminary pyelogram had been done, we do not know just when the hydronephrosis developed. Death from cancer five months after treatment, and two months after the hydronephrosis was discovered, makes it difficult to say whether this case should be included. It certainly is unusual in our experience to have hydronephrosis develop so early after treatment. In another case a large ulceration of the trigone associated with nodules along the urethra was re-treated with radium needles plus roentgen irradiation one year after primary treatment for Stage III carcinoma of the cervix. A cystoscopy two years later showed hydronephrosis. She survived for eight years after the primary—seven years after re-treatment—finally died of cancer. With these 2 cases included, we have 8 cases of hydronephrosis and hydroureter due to radiation injury—8 of 489 cases, or 1.6 per cent. We now have adopted the practice of routinely doing pyelograms on all but the early cases.

TABLE VII

URINARY COMPLICATIONS OTHER THAN FISTULAS

Hematuria	7
Ulcer of bladder	4
Obstruction of ureter with hydronephrosis or pyonephrosis (due to treatment)	8
Total	19—3%

Intestinal Complications—Not Fistulas. Although fortunately not frequent, intestinal complications when they occur are much to be dreaded. Mild proctitis is often encountered, especially with the added use of deep roentgen therapy. Usually this is not of long duration but when persistent and accompanied by a bloody or mucous discharge, it should be watched with care as an early symptom of the development from serious lesions. These mild complications have not been included in this study.

Rectal ulceration usually occurs back of the vaginal fornix or cervix and is usually accompanied by a hardening and thickening about the circumference of the bowel resulting in an annular ring or constriction with parametrial and perirectal fixation. This gives the impression of recurring cancer and has often led to more treatment with roentgen radiation, to the patient's detriment. In 1 case (1932) we did a radical resection of uterus and rectum for such a lesion to find that the rectum contained no cancer but an irradiation reaction. The uterus did contain uncontrolled adenocarcinoma which seemed to justify our procedure. We have had 10 cases of severe rectal or sigmoidal ulcers in this series, the last, an incidental autopsy finding,

occurring in 1937; 10 of 489 or 2 per cent. Three cases of small bowel ulceration and stenosis were all associated with stump cases, the ileum being adherent and damaged by the radium or perhaps the radium broke down cancer-invaded intestinal wall.

There were 2 cases of ulcer of the rectosigmoid which perforated with resulting peritonitis and death. This accident occurred four months after radium treatment and six months after roentgen irradiation in the first case, and nine months after radium and three months after roentgen irradiation in the second. The first had operation with findings of perforation and peritonitis; an autopsy established the diagnosis in the second case. We have 1 case of necrosis and perforation of the transverse colon, remarkable because we were able to get her into the hospital and repair her intestine in time to save her life. This perforation occurred three months after roentgen irradiation and two months after radium treatment. She later developed both rectovaginal and vesicovaginal fistulas. The rectovaginal fistula closed spontaneously and after several years we successfully closed the vesicovaginal fistula. She is now alive and well, free of disease nine years after her original treatment.

TABLE VIII

SUMMARY OF INTESTINAL COMPLICATIONS

Ulceration and obstruction of small bowel	3	
Ulceration of rectum and sigmoid	10	
Perforation of sigmoid	2	
Perforation of transverse colon	1	
Total (fistulas not included)	16,	or 3.3%
Rectovaginal fistulas in needle treated cases	22,	or 4.4%
Total severe intestinal injuries in 489 needle treated cases	38,	or 7.7%

Severe Inflammation. A careful search of our records shows that severe inflammatory reactions have not been a frequent accompaniment of treatment by this type of interstitial needle. As we have never withheld treatment because of low grade temperature, or made it our practice to remove needles in the course of treatment for slight rises, we think that our low incidence of severe inflammatory reactions is significant.

TABLE IX

SEVERE INFLAMMATORY REACTIONS

The following cases of severe inflammatory reaction were found:

Pyometrium	2	
Retroperitoneal abscess	1	
Pelvic inflammatory disease	3	
Total	6	or 1.2%

Severe Inflamation—6 cases in 489—1.2 per cent

1. Pyrometrium—2 cases
 (1932) One case Stage III—1932—developed pyometrium requiring dilatation and drainage three months after treatment with roentgen radiation and needles. The cancer was not controlled and she died within one year.
 (1933) A second case—Stage III—required dilatation and drainage five months after treatment. She lived fourteen years but died of massive pelvic recurrence with spinal metastases.
2. Retroperitoneal abscess—1 case
 (1933) One case—Stage III—developed retroperitoneal abscess described as on right side between liver and transverse colon—required drainage through right rectus incision. Now alive and well after fourteen years.
3. Pelvic inflammatory disease—3 cases.
 (1934) 1. Pelvic abscess—Stage IV—drained abdominally ten days after treatment. Died three months later of cancer.
 (1933) 2. Acute pelvic inflammatory disease—Stage III—high temperature for several weeks after treatment. Had roentgen irradiation and radium at same time. Roentgen irradiation 3/8 to 4/26/33, radium 3/10 to 3/17/33. This patient died seven and one-half years later of a massive recurrence of cancer.
 3. Pelvic inflammatory disease—Stage II—also in 1933. Roentgen irradiation and radium given at the same time. Roentgen irradiation 7/21 to 8/23/33. Radium 7/29 to 8/4/33. Had very very severe flare

up which subsided in two weeks. Required surgery for residual inflammatory masses in tube and ovaries and for peri-appendicitis five months later. Now alive and well without recurrence fourteen years.

SUMMARY

The authors have reviewed a series of 621 cases of cancer of the cervix—1926 to 1941. Four hundred and eighty-nine of these were treated primarily by interstitial irradiation with the long radium element needles. Complications of immediate mortality, fistula formation, urinary and intestinal lesions—not fistulas—and severe inflammatory pelvic reactions have been described as they occurred in this clinic.

The incidence of these complications has not exceeded in general that reported by other clinics using other methods.[1,2,3,4,7,9,10]

CONCLUSIONS

Interstitial irradiation by the long radium element needles has been relatively a safe method in our experience and has not been followed by a high incidence of complications.*

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* For discussion see page 797.

POSTIRRADIATION ULCERATIONS OF THE UTERINE CERVIX*

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LATE postirradiation complications involving the bladder and rectum in cases of carcinoma of the cervix are now recognized and frequently anticipated. These complications generally occur months or years after radiation therapy and are caused by occlusive vascular changes. Some difficulty is experienced from time to time in differentiating the postirradiation complications, in the form of necroses or ulcerations, from recurrences or extensions of carcinomatous growths.

Similar postirradiation ulcerations caused by vascular occlusions occurring in the cervix itself would cause considerable diagnostic difficulty.

Four such cases were encountered occurring in a three year period among 99 patients with cervical carcinoma treated with roentgen and radium therapy in the Tumor Clinic of The Western Pennsylvania Hospital in Pittsburgh.

CASE REPORTS

CASE I. A colored woman, aged thirty-six, weighing 114 pounds , with a vaginal discharge for three months, had a fleshy, friable mass 3 cm. in diameter in the cervix involving mostly the anterior lip. It was classified as a League of Nations Stage II. Microscopically, this tumor showed all degrees of differentiation, but was predominantly Grade 3, on a basis of Grade 4 being the most undifferentiated.

High voltage roentgen treatments with 200 kv. and 0.5 mm. Cu filtration were given over a period of twenty days and consisted of 1,800 roentgens (measured in air) to each of four areas 10 by 15 cm. in size over the lower part of the abdomen and the sacrogluteal regions. This was applied at the rate of 150 to 200 r to each of two portals daily, except Sunday, alternating front and back. The estimated tumor dose was 2,380 r. Two weeks later radium was inserted for thirty hours. A total of 3,000 milligram-hours was administered. A 50 mg. radium capsule filtered with 1 mm. of platinum was placed in the cervical canal, and four 10 mg. radium needles each 2 cm. long and filtered with 0.5 mm. of platinum were inserted in the parametrium, and one 10 mg. needle into the anterior cervical lip. It was estimated that the posterior fornix received about 7,500 gamma roentgens; the anterior cervical lip about 9,700 gamma roentgens and the parametrium 2,850 gamma roentgens, all measured on a plane at the end of the active length of the radium. A biopsy of the cervix just prior to the radium therapy showed no evidence of neoplasm.

The cervical lesion healed completely. However, seven months later the vaginal vault presented a crater 4 cm. in diameter. The edges of the crater were indurated and the lesion was considered neoplastic. Microscopically, however, no evidence of neoplasm was seen.

At the end of the following month additional biopsies were performed on the cervix and crater. These also failed to show any evidence of neoplasm. There was extensive hyaline necrosis with associated panarteritis, phlebitis and thrombosis.

Two months later several small radiation ulcers were noted in the bladder wall. The cervix was improved and fleshy granulation tissue was present.

During the following year the patient failed to report. She was symptom free and had gained weight.

Two years after radiation therapy, partial intestinal obstruction developed and at laparotomy extensive peritoneal metastases were proved histopathologically, but the cervix and adnexa were free of disease. The patient died of abdominal carcinomatosis one month later.

CASE II. A colored woman, aged thirty-four, weighing 115 pounds, had vaginal bleeding for two months. The cervix was fixed and the parametrium was infiltrated—a Stage III. Friable, neoplastic tissue was present in the cervical canal. Biopsy showed a Grade 3 squamous cell carcinoma. Roentgen treatment, with a total

* Presented at the Forty-Eighth Annual Meeting, American Roentgen Ray Society, Atlantic City, N. J., Sept. 16–19, 1947.

of 1,600 r in air to each of four portals about the pelvis with an estimated tumor dose of 2,120 r, was given in a period of three weeks. This was immediately followed by the insertion of radium, two 50 mg. capsules in tandem in the uterus and cervix and four 10 mg. needles into the parametrium, for twenty-four hours, or 3,360 mg-hr. The radium dosage in gamma roentgens was only slightly greater than in the first case; that is, 8,000 in paracervical tissues, 9,000 in cervix, and 3,000 gamma roentgens in the parametrium.

One month later there was improvement, but at the end of another three months a small raised area was noted at the site of the posterior cervical lip. Microscopically, this showed extensive hyaline necrosis of vessels associated with diffuse necrosis of tissues and leukocytic infiltration, but no evidence of neoplasm.

This lesion improved for a short time, but then deteriorated, so that eight months later a large slough was removed from the region of the cervix. Under the microscope this tissue showed hyaline necrosis and thrombosis of large and small vessels. No tumor cells were present.

Another large slough was removed from the same site one month later, leaving a rectovaginal fistula. The rectovaginal fistula healed, but a vesicovaginal fistula formed. Later this was successfully repaired and the cervix was absent. Seven years after the radiation therapy there was no evidence of tumor recurrence or metastases.

CASE III. A colored woman, aged thirty, weighing 124 pounds, with vaginal bleeding of six months' duration, and a recent profuse hemorrhage had an ulcerative and proliferative lesion at the external cervical os which proved to be a Grade 3 squamous cell carcinoma histopathologically, and Stage III clinically.

Over a three week period, 1,550 r was given to each of two anterior pelvic and 1,450 r to each of two posterior pelvic portals with an estimated tumor dosage of 2,000 r. No microscopic evidence of neoplasm was found one week after completion of these treatments. Following the biopsy, one 100 mg. tandem of radium was inserted into the uterine and cervical canals and four 10 mg. needles were placed around the circumference of the cervix. These remained in place for twenty-eight hours or a total of 3,920 mg-hr.

Seven months later the vagina was greatly contracted and there was hard, nodular and partially necrotic tissue, which did not bleed readily, in the vaginal wall. The posterior lip of the cervix was also hard and nodular. Microscopic examination of these tissues showed no evidence of neoplasm.

One month later, two additional biopsies were made of the cervix and vagina because of the resemblance of these lesions to carcinoma. There was, again, no evidence of neoplasm, but severe radiation changes with many occluded vessels were present.

A vesicovaginal fistula developed which gradually improved over a period of eighteen months. The patient is living with urinary incontinence, but without evidence of neoplasm seven years after the radiation therapy.

CASE IV. A colored woman, aged twenty-nine, weighing 110 pounds, had been spotting for three weeks. There was a large fungating mass in the cervix which was friable and bled easily, a League of Nations Stage II. Sections showed a Grade 3 squamous cell carcinoma. Roentgen treatments were given over a period of twenty-three days and consisted of 1,550 r to each anterior pelvic region and 1,750 r to each sacrogluteal region for a tumor dose of 2,310 r. Radium was then inserted for twenty-four hours; two 50 mg. tubes into the fundus and cervix and five 10 mg. needles radially into the paracervical tissues for a total of 3,600 mg-hr.

Check-up examination seven months later showed the radiation reaction had subsided. The cervix was healed and clean; the uterus movable and the parametrium free. The patient had gained weight.

During the following month rectal bleeding developed, and at the end of the month a crater was found in the vaginal vault. This had a gray base and an indurated, red border which was suggestive of recurrent malignancy. However, under the microscope, no evidence of neoplasm was seen.

Additional changes in the vaginal vault, which suggested recurrent tumor and which prompted biopsies, were noted two, three, seven and eight months later, a total of 5 biopsies negative for neoplasm within one year. None of these showed any evidence of tumor cells.

The patient was well seven and one-half years after radiation therapy. There was no evidence of recurrence. The vaginal lesion remained healed. The patient had gained 65 pounds and had no complaints.

DISCUSSION

In each of these cases lesions developed at or near the site of the original cervical carcinoma which suggested a recurrence of the malignant growth. In one of these the impression was so strong that, pending the report of the biopsy, a hopeless prognosis was considered.

In the sections of the lesions from each of these cases the classical vascular occlusive changes secondary to irradiation were demonstrable. These vascular changes caused infarction with the associated necrosis and ulceration. Treatment consisted simply of daily boric acid vaginal douches.

We were impressed by the fact that all our cases occurred in young, thin, colored women and the ulcerations developed approximately eight months after treatment when the radiation reaction had subsided.

Equal or larger amounts of irradiation with a similar technique were received by other patients, both colored and white, during the same period without the development of this complication. It is believed that the vascular apparatus of some individuals is more vulnerable than others or that the ability to form scar tissue is greater in some patients. None of this group had serology positive for syphilis.

Only by microscopic examination of tissues from the suspected lesions was their true nature established, and additional damage was avoided by withholding further radiation treatments.

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DISCUSSION OF SYMPOSIUM ON CANCER OF THE UTERINE CERVIX*

DR. JAMES A. CORSCADEN, New York. It is indeed a great privilege to be invited to discuss these important gynecological papers—important because cancer of the cervix is second in frequency only to cancer of the breast; and second, because no matter how desirous one might be to operate on all cancer, by the surgeon's own statement only 15 per cent are eligible, leaving 85 per cent of this very common disease needing roentgen rays and radium for their therapy.

The chronicity of Dr. Jacox' cases I think is typical and should warn us against secondary irradiation after apparently adequate irradiation has already been given. The longest interval in my experience between irradiation and the vesicovaginal fistula is twenty-two years. Almost anything could have caused that fistula in that long interval. It raises in my mind the question of the wisdom of giving these secondary treatments. In our experience, the results do not warrant the risk.

In looking over these accidents, there seem to be two groups of causes: the uncontrollable, and those which may be controlled. I have been more interested in trying to study those factors which might help us avoid the injuries, and first is the time factor. In Dr. Jacox' cases the radium was given in from twenty-four to thirty hours and the roentgen radiation in from twenty days to four weeks. I want to illustrate these questions by some experiences of our own.

(Slide) This is a slide of 2 patients, both very similar in complexion, and so forth, and superficially comparable. I wish to point out that among all these factors, the essential difference between the 2 cases is the duration of the treatment. The first woman received 6,400 r in eighteen days. The other woman received 9,000 r in forty-five days. The first woman died with ulceration of the skin, perforation of the intestine; the other was perfectly well, with practically no symptoms whatever.

The next slide expresses the same idea in radium. Up to about 1937 we used to give 175 mg. for forty hours, and in those cases there were 10 per cent of clinically important injuries—the late injuries, not the discomforts experienced during treatment. We changed to 70 mg. for 100 hours, giving the same total, and there have been none of these late complications.

The next question I would like to ask is, how far were the bladder and intestine from the radium units as applied? (Slide) This is a diagrammatic drawing, drawn so that the distance from intestine to radium in the upper dia-

* Papers by Drs. Waterman and Tracy, and Jacox.

gram is half the distance of that in the lower. Obviously, the intestine close to the radium would receive four times the dose the bowel would in the other. In the roentgen treatment, that is pretty well calculated in most cases, but because of the difficulties of measurement in radium, it is almost always omitted in the expression of dosage.

Turning to Dr. Waterman's cases, I think, first, we should thank him for such a frank and clear presentation of his accidents; and second, compliment him on the low incidence. The vagueness of the area into which these needles are plunged makes one apprehensive that they may be entering bowel, bladder, or ureter, and I think it is important to see that his fistulas, among the cases that have been cured of cancer, are very small in number. I cannot get interested in fistulas accompanied by cancer. There are so many variables that we have nothing to calculate upon. I think we should concentrate upon the so-called cured case that does have fistula, and in his series the number was very small.

The question comes up in his cases whether the distribution of the radium might have had some effect on the results. The next slide shows the typical intracavity irradiation by various techniques where occasionally the radium is crowded into the uterus and fornices. Five or six thousand milligram-hours given in forty-eight hours would be a heavy dose. Given in a week 7,000 or 8,000 mg-hr. would be very high and close to the danger point.

This slide shows the pelvis peppered with radium needles, and the next slide diagrammatically shows the radium scattered throughout the pelvis. This, in total, is a little over 100 mg. for 120 hours, giving 12,000 milligram-hours without injury because the needles each contain a small amount of radium and are widely dispersed. In calculating dosage the disposition of the radium must always be taken into account.

The next slide confirms Dr. Waterman's emphasis on the necessity of calculating the radium plus the roentgen-ray dosage, at any particular point. The vast majority of intestinal lesions occur in the rectosigmoid, not exactly where the maximum amount of radium was, caused by the combined action of roentgen rays and radium.

Finally, I would like to show another slide to take the action of the irradiation on the intestine out of the mystery class. It seems to me that the intestinal mucosa is specifically susceptible, and this slide shows that. This is the patient who died from over-irradiation. I would like to point out that there is very little reaction in the peritoneum. The muscularis is pretty much intact, although the irradiation came from outside, but the intestinal mucosa is badly disintegrated. In other words, the radiation dosage should be expressed in terms of what the intestinal mucosa will bear rather than in tumor doses, because this actually is what limits the amount of irradiation which we are able to give.

DR. ARTHUR W. ERSKINE, Cedar Rapids, Iowa. The conclusions of Drs. Waterman and Tracy and Dr. Jacox agree fairly well with those published by Watson, Herger and Sauer in the June, 1947, number of the *Journal of Urology*. It seems that we can expect serious irradiation injuries in at least 3 per cent of the patients who live three or four years after being treated skillfully, carefully and adequately for pelvic malignancies. There must be at least three reasons for the increasing number of reports of such reactions: (1) radiation therapists are using larger, and more nearly adequate dosage; (2) we are looking for reactions, and as both essayists have pointed out, are less likely to mistake them for recurrences; (3) more patients are recovering. It is obvious that if 50 patients out of 100 live five years, more reactions will be seen than if only 25 survive.

Reports, such as these, might tempt the faint hearted to avoid radiation sequelae and other unpleasant complications by refraining from using adequate dosage. The only point I wish to make is that no such inference can properly be drawn. We know these essayists and we know that their patients were treated carefully and skillfully. In spite of that care and skill some patients developed unpleasant, painful, and dangerous reactions. Those reactions should have the same significance as operative deaths. The nature of our calling demands that we have a certain amount of fortitude. We deal with human life and with a cruel, insidious, deadly disease. If we treat our patients with that disease fairly, if we are doctors, we shall accept a definite morbidity and mortality rate just as surgeons and all good doctors do.

DR. G. E. PFAHLER, Philadelphia, Pa. I would like to ask a question of Dr. Waterman as to the size and length of the needles, the quantity

of radium content, and some details about his technique of application.

Dr. Charles M. Richards, San Jose, Calif. I have been very much interested in these presentations, particularly that of Dr. Jacox, because, as all of us know who have been in this work for a good many years, we have these things come up, and it is not very pleasant, after you have seen a case of cervical cancer in the office or in the hospital month after month, staying perfectly well, to have the patient appear all of a sudden with a large ulcer.

There are certain things that we notice that enable us, I think, to make a clinical diagnosis and therefore allay our fears, even without biopsy of this particular ulcer. My experience is that these things are definitely not hyperplastic in character. They are obviously and characteristically decadent in character.

The question comes up as to what to do. I note that Dr. Jacox says his patients have been cured of the radium necrosis of the cervix with just boric acid irrigations. We have found very helpful the use of some of the nitrogen products, such as allantoin and urea products combined with some local sulfathiazole application, and a packing every other day with an ointment of this material followed by irrigation the second day with 1–5,000 potassium permanganate solution. We have found this treatment very helpful in clearing up these radiation necroses.

One or two other ideas come to mind as to the distribution of the time of the irradiation. In many quarters it seems that the time interval between the deep roentgen therapy and the local radium application, whichever one comes first, is an important factor in allowing a certain amount of recovery of the normal tissues from the unavoidable exposure to irradiation. The recent tendency has been to increase the time between radium application and roentgen-ray application in order to allow this recovery of normal tissue.

Another very important point which was brought out many years ago, I think by Dr. Healy at Memorial Hospital, is the necessity of watching the direction of our primary beam in irradiating the pelvis with deep roentgen therapy to avoid central concentration of the beam into the area where local radium has been applied.

Dr. U. V. Portmann, Cleveland, Ohio. I would like to call attention to a complication that may result from radiation therapy for cancer of the cervix which has not been mentioned by the essayists. Several years ago there was a report from the Cleveland Clinic about patients having symptoms, signs, and roentgenologic evidence of obstruction of the small intestine who had had radiation therapy for cancer of the cervix a year or more previously. At operation a segment of the small intestine was fibrosed, and after removal recovery was uneventful. At first the surgeon who had used the radium attributed the condition to roentgen therapy until it was pointed out that one of these patients had not been so treated.

The symptoms of obstruction might be erroneously attributed to extension of the malignant disease. Possibly patients who were thought to have died of carcinoma have actually died of this condition. When a woman who has had radiation therapy for carcinoma of the cervix complains of symptoms of intestinal obstruction, even several years after treatment, she should have a roentgenologic gastrointestinal examination. The condition can be readily recognized, and resection of the affected segment is indicated.

Dr. Waterman (closing). I should like to answer Dr. Pfahler, and to say that these needles are long needles; the 3 mg. needles are 60 mm. long and the 2 mg. needles 45 mm. The entire detail of these instruments was very carefully described in the article which I read before the American Radium Society last year, and which was published in the July, 1947, issue of the American Journal of Roentgenology and Radium Therapy. I should be very glad to forward a reprint of that article to Dr. Pfahler if he would like to have one.

Dr. Jacox (closing). I had no axe to grind in presenting this paper, because I would like to know what caused this complication. Dr. Corscaden didn't answer it. Other people both white and colored, were treated during the same time, and a five year survival rate of 33 per cent of all cases was established during this same time. So, just why these individuals were susceptible, I don't know.

I have been looking for this in a white woman. We had one where we thought that was the case. We had a number of negative biopsies—that is, negative for cancer—but that woman eventually died of what we considered clinically distant metastases. The local area cleared up. Unfortunately, we did not get an autopsy or operative specimen as we did in the first case.

I don't know what the reason for this ulceration is. Maybe we overtreated them. There must have been something wrong, or the fact that these people just could not take it. I do not know how to pick them out in advance. If anyone has any suggestions, I would like to hear them.

The point that Dr. Richards brought up is most important, I believe: the time interval between the roentgen-ray series and the insertion of the radium. As you all know, if you wait too long you will have closure of the cervical canal and you cannot get the radium in. My thought is to hit the cancer as hard and as fast as you can and you will get a small percentage of these troubles, as Dr. Erskine stated.

It did not seem to make much difference what we put on these ulcerations. You see the trouble goes back of all that. You can put all kinds of things on the surface of the ulcer and if you do not get what is down underneath it out of the way—which in this case happened to be the thrombosed, obliterated end arteries and all the changes I mentioned—all you can do with the surface is keep it clean, and if it will heal it will heal by collateral circulation. I believe that is the fundamental thing.

If I may, I should like to say something about what Dr. Waterman mentioned in these early cases. He did not say why he thought he got bladder complications in some of them. That is a distressing thing, to get bladder ulceration or hematuria in an early case, we will say in a Grade 1 or Grade 2, and I think it has a lot to do with the cancer acting as a filter, and when you have a small amount of cancer and you give the same dose that you give when you have a large amount, then you do not have the cancer acting as an absorbing structure to take up the radiation and be eliminated if the cancer disappears. That is one explanation. It may not be all, but if anyone has any suggestions or ideas about this, I would be glad to hear from him afterwards.

TREATMENT OF CANCER OF THE PENIS AT THE NORWEGIAN RADIUM HOSPITAL*

By ROLF BULL ENGELSTAD, M.D.
OSLO, NORWAY

STUDY of the literature on the treatment of cancer of the penis indeed reveals a very extensive use of radiation treatment, as a rule, however, combined with preceding more or less radical surgical interventions. In a work from Radiumhemmet, Stockholm, Hansson[1] recommends amputation of the penis followed by radiation treatment for the great majority of cases. Radiation treatment alone will, in his opinion, essentially come into consideration for local irradiation (contact or interstitial application) of small superficial tumors, and for some advanced cases with inoperable glandular metastases, where amputation of the penis for palliative purposes is not considered safe. Metastases to the lymph nodes are first irradiated and, if necessary, followed by dissection of the inguinal glands.

The rather unsatisfactory results of radiation treatment alone from Radiumhemmet as from many other tumor clinics are, according to Hansson, attributable to several unfavorable factors. First, these tumors are highly differentiated spinocellular carcinomas with comparatively slight radiosensitivity. Second, infection of the phimotic prepuce is a frequent complication. Third, the prepuce and glans are apt to develop a radionecrosis.

As opposed to the routine of many other clinics, primary radiation treatment of cancer of the penis has been much used at the Norwegian Radium Hospital.

The usual procedure here has been first to perform a phimotic operation of some kind, and follow this by radium treatment of the penis tumor, using partly teleradium with doses of about 500 gamma roentgens a day, partly radium on a cylindrical wax mold (two halves of a cylinder), with a radium skin distance of 0.7 cm. (on rare occasions 1.5 cm.), and with daily doses of 500–700 gamma roentgens. As a rule, the total dose has been 3,500–3,700 gamma roentgens, occasionally about 4,000 gamma roentgens. For persistent tumor or for recurrence, the main rule is amputation of the penis. If the patient has already been operated upon at another hospital and arrives with or without recurrence radiation treatment is given, usually in the form of teleradium over the penis stump and the groins.

Roughly, the same methods are used for treatment of the glandular regions as for many other malignant tumors, beginning with radiation treatment, usually teleradium with doses of 3,500–4,000 gamma roentgens, whether or not metastases are demonstrable. For persistent glandular metastases dissection of the groins is done after six to eight weeks. The same treatment is also used for later occurring metastases to the glands. A disadvantage of the procedure, however, is that on really radical dissection of the groins subsequent to irradiation with large doses, necrosis of the skin is apt to develop, considerably delaying the course, and it may also lead to the formation of massive scar tissue, interfering with an effective control examination of this region during the further course.

The procedure that I had an opportunity to see at Radiumhemmet some time ago—namely, dissection of the groins to remove a fair section of the irradiated skin, sewing edges of the wound to the underlying layers, and covering the defect with skin graft—eliminates or reduces the above mentioned disadvantages, and therefore it seems an essential improvement upon the surgical methods. Also at this hospital the

[1] Hansson, C. J. Cancer of penis and its treatment. *Acta radiol.*, 1938, *19*, 443–457.

* From the Norwegian Radium Hospital, Oslo, Norway. Chief: Rolf Bull Engelstad, M.D.

procedure has been used in a few cases.

For treatment of the penis carcinoma proper we have, as mentioned, in the majority of cases used primary radiation treatment. As will be seen in the following, amputation of the penis has often been necessary at some later time, because of persistence or recurrence of the tumor. In these cases, however, a less radical amputation has been considered permissible. A limited electrocoagulation instead of amputation has been considered sufficient in a few cases.

We have wished to present our material on cancer of the penis, not because of any essential difference between our results regarding lasting freedom from symptoms, and those of others, but because the material, on account of the treatment methods employed, may possibly contribute to the illumination of the problem of the radiosensitivity of these tumors.

In course of the years 1932–1942 inclusive, 72 histopathologically verified cases of carcinoma of the penis have been treated, while during the same period we have, in male patients, had 601 cutaneous carcinomas, 473 labial carcinomas and 16 anal carcinomas, thus making a total of 1,162 carcinomas of the skin and in the areas around the natural openings of the body. In the present material carcinoma of the penis is thus not a frequent form of tumor, constituting no more than 6.2 per cent of the total number of the above mentioned growths. During the same period we have had 144 cases of carcinoma of the vulva.

Distribution as to age is seen in Table 1.

TABLE I

	Cases
30–39 years	3
40–49 years	13
50–59 years	15
60–69 years	22
70–79 years	11
80–89 years	8
	72

Manifestation of the condition before the age of forty is apparently rare, and the largest number of cases in our material is found in the fifties and sixties.

Phimosis, luetic infection and trauma have been mentioned as etiological factors. In fact, lues as well as a history of earlier trauma has been given by some of our patients, but the material allows no conclusions to be drawn as to the importance of these conditions. The presence of phimosis is fairly frequent, being found in 50 of 72 patients, that is in 69.4 per cent.

The importance of phimosis as a predisposing factor in the development of carcinoma of the penis is so well known that further discussion of the condition is unnecessary here. Only the prophylactic importance of treating every case of phimosis will be emphasized. It is true that very few patients with phimosis do develop carcinoma of the penis. But an early instituted treatment of the condition will, besides having a cancer prophylactic effect, also save the patient several, if less serious troubles, such as acute, recurrent and chronic balanitis, and the sometimes rather considerable pain on coitus. In my opinion an operation is important not only in the presence of complete phimosis, but also in incomplete cases, as also in the latter cases the condition may easily lead to deficient cleanliness.

When cancer develops in a patient with phimosis, we make a point of starting the treatment with a phimosis operation, preferably extirpation of the prepuce. If this cannot be done, at least a slit is made. This practically always facilitates the accomplishment of the radiation treatment, and also allows a more effective control of the condition during its further course.

Thirty-four of our 50 patients with phimosis were operated upon for the condition. In the 16 remaining cases there were either various obstacles in the way of an operation (adhesion of prepuce and glans, extensive tumor infiltration of prepuce and glans), or the prepuce or the entire foremost part of penis had been destroyed, or amputation of the penis had already been performed before admission.

For classification of our cases of cancer of the penis we have used Berven's method, based on condition of the lymph node metastases, with the difference, however, that Stage I has been divided into two subgroups.

Stage I: Without demonstrable metastases to the lymph nodes.
(Stage Ia.: Maximal diameter of penis carcinoma $\leqq 2$ cm.
Stage Ib.: Maximal diameter of penis carcinoma $\geqq 2$ cm.)
Stage II: Clinically demonstrable metastases to the lymph nodes, confined to the lymph nodes proper. Operable.
Stage III: Metastases to the lymph nodes with signs of perforation of the capsule. Inoperable.

The classification by stages thus is based on the clinical diagnosis of metastases to the lymph nodes and their operability, in both of which conditions an estimation may be difficult. The clinical determination of whether or not the enlargement of a gland is attributable to metastases may sometimes be easy, at other times exceedingly difficult or impossible. In Stage II therefore have been included only cases in which size and consistency of the glands make the diagnosis of cancer fairly certain. Also the question of operability of the case may be difficult to decide. On a whole, however, a classification on these principles is feasible and fairly definite.

The present material shows the following distribution to the various stages (Table II):

Table II

Stage I		36 (50%)
Ia	15	
Ib	21	
Stage II		28 (38.9%)
Stage III		8 (11.1%)

We shall at once proceed to study the total results, regardless of the treatment methods employed. Table III gives the patients who are alive and symptom free after three and five years respectively. The diagnosis has in all cases been histopathologically verified.

Table III

	3 Years		5 Years	
	Total	Symptom free	Total	Symptom free
Stage I	36	32 (88.9%)	27	24 (88.9%)
Stage Ia	15	14 (93.3%)	11	11 (100 %)
Stage Ib	21	18 (85.7%)	16	13 (81.3%)
Stage II	28	19 (67.9%)	22	14 (63.6%)
Stage III	8	0	8	0
	72	51 (70.8%)	57	38 (66.7%)

Table IV

Stage I

	Total	Symptom Free	Died from Cancer	Died from Intercurrent Disease
Radiation treatment	20	18	1	1 (3 yr.)
Radiation treatment plus electrocoagulation	4	3	1	
Radiation plus surgical treatment	10	10		
Surgical plus radiation treatment	1	0	1	
Surgical treatment	1	1		
	36	32	3	1

I will not dwell at length on these results, which although apparently somewhat better than those usually seen, still are found roughly to be about the same. There is reason to point out the singularly favorable

prognosis for early cancers of the penis without metastases to the lymph nodes, the considerably poorer, if still relatively good prospects for Stage II, and the bad prognosis where inoperable metastases are found.

Considerably more interesting in this connection is trying to obtain some impression as to the effect of the radiation treatment. The results for Stage I (Ia and Ib collectively) have therefore been grouped according to the treatment methods employed (Table IV).

The corresponding results for Stage II are found in Table V.

The 8 patients belonging in Stage III were all far advanced cases with regard to development of the primary tumor and metastases. Six of these received only radiation treatment, whereas 2 had been operated on beforehand, and on admission had inoperable glandular recurrence, 1 also had recurrence of the primary tumor. One of these was treated with radiation, whereas the second one was considered intractable. All 8 patients died from cancer.

To study the course of the development also in the patients who died may have some interest. Table VI gives the causes of death; that is, to the best of my judgment I have attempted a characterization of the development that appeared mainly responsible for the fatal outcome.

Of patients dead of Stage Ia only 1 showed progression of the primary tumor. This patient had been operated on earlier, and arrived at this hospital with local recurrence without metastases to the glands. Here he received radiation treatment only. For the rest the table shows progression of metastases to the glands, alone or associated with progression of the primary tumor, to be the main cause of death in most cases.

In the two tables presenting the results of the different treatment methods (Tables IV and V), the treatment, as a whole, of the condition has been considered; that is, treatment of the primary tumor and of the metastases to the glands. The principles of our treatment of metastases to the glands have already been stated and will not be further discussed. It will merely be pointed out that the regional lymphatics are always irradiated, whether or not they are suspected, and also the importance stressed

TABLE V

STAGE II

	Total	Symptom Free	Died from Cancer	Died from Intercurrent Disease
Radiation treatment	10	7	2	1 (2 yr.)
Radiation treatment plus electrocoagulation	1	1		
Radiation plus surgical treatment	13	8	5	
Surgerical plus radiation treatment	3	3		
Surgical treatment	1	0	1	
	28	19	8	1

TABLE VI

	Stage Ia	Stage Ib	Stage I	Stage II	Stage III
Intercurrent disease		1	1	1	
Progression of the primary tumor	1		1	1	1
Progression of the glandular metastases		1	1	2	4
Progression of the primary tumor and glandular metastases		1	1	3	3
Distant metastases				2	
	1	3	4	9	8

of not delaying dissection of the groins, if after preceding irradiation there are found persistent, newly formed or recurrent metastases.

Finally, an analysis will be attempted of the data in the material regarding effect of the radium treatment upon the primary tumor proper, in order to gain an impression of the radiosensitivity of cancer of the penis. It is evident that interest in this connection is centered on the patients receiving primary radiation treatment with or without subsequent surgical operation, to the exclusion of primary operated and later irradiated cases (Table VII).

the information that complete destruction of the primary tumor after irradiation has been obtained in 30 of 64 cases in all stages; that is, in nearly half the number of cases (46.9 per cent). Considering only Stages I and II—the really tractable ones—it is seen that of 64 patients 58 received primary irradiation, which in 31 was the only treatment. In the latter cases a satisfactory local effect has been obtained in 29: that is, in exactly half the number of all primary irradiated cases.

Also in most of the patients in whom operation has later become necessary, there has been a marked radiation effect, in some

TABLE VII

	Total	Primary Radiation Treatment			Dead	
		Radiation treatment only	Later electro-coagulation	Later operation	Local symptom free	Local recurrence
Stage Ia	13	6	2	5	13	0
Stage Ib	21	15	2	4	20*	1
Stage I	34	21	4	9	33*	1
Stage II	24	10	1	13	20*	4
Stage III	6	6			1†	5
	64	37	5	22	54	10

* Of whom 1 dead from intercurrent disease.
† Dead, progressive glandular metastases.

Of the total material of 72 patients, no less than 64 have received primary radiation treatment, 37 this treatment only. Of the 37 cases, 28 are alive and symptom free. Two have died free of symptoms and from intercurrent disease three and two years respectively after the treatment, whereas 7 have died from or with local recurrence.

In 27 of the 64 primary irradiated cases has remaining tumor or recurrence later made surgical intervention necessary (electrocoagulation in 5 and amputation of the penis in 22 cases). Of these, 24 are locally symptom free, 3 have died with local recurrence.

For illustration of radiosensitivity of cancer of the penis the material supplies

primary clinical freedom from symptoms. Further, we have the definite impression that irradiation has offered the advantage of permitting a more conservative surgical intervention, where this has later had to be done. We also feel justified in concluding from the material that in cases where operation has become necessary in spite of preceding radiation treatment the postponement of the operation, conditioned by the primary irradiation, has by no means reduced the patients' chances for recovery. On the contrary, it seems to have had certain unquestionable advantages.

The radiation treatment has nearly always been carried out according to plan. Never has an already present infection meant an essential obstacle. In exceptional

cases only has this caused an interruption of the treatment, but never for long. No serious, prolonged radionecrosis has occurred in these cases, except in 2 cases with practically complete destruction of the penis, where some necrosis developed in an ulcerated tumor over the os pubis, around the root of the penis. However, the extent to which this necrosis was attributable to the irradiation is difficult to decide. In some other cases the healing process may have been somewhat slow, however without causing much inconvenience. In the majority of cases the course of the irradiation reaction has been practically the same as that usually seen in other regions.

We have asked ourselves the reason why our experiences with primary radiation treatment of cancer of the penis apparently are considerably better than those from many other tumor clinics, with regard to the radiosensitivity as well as to practicability of the treatment. I believe that probably the following conditions have played an essential part in this connection:

The radiation is always given using a greatly protracted or protracted-fractionated technique, either with radium on a mold or by means of teleradium. Direct contact or interstitial application (needles) is not used. In the presence of phimosis the prepuce, if at all possible, is always extirpated before irradiation, or where adhesions or tumor infiltration prevents this, partial removal is done or a slit is made, so that good drainage is provided for, and conditions obtained for the most effective control during the further course.

SUMMARY

A material consisting of 72 cases of cancer of the penis treated at the Norwegian Radium Hospital is here reported. Sixty-four of these cases have had primary radiation treatment, in 37 of which it was the only treatment (apart from phimosis operation). Of the latter 28 are locally symptom free, 2 have died symptom free from intercurrent disease, and 7 have died with local recurrence. Because of remaining tumor or recurrence surgical intervention (electrocoagulation in 5 and amputation of the penis in 22 cases) has later become necessary in 27 cases. Of these 24 are locally symptom free, while 3 have died with local recurrence. In the total material freedom from symptoms after three and five years respectively has been found in: 93.3 per cent of 15 and in 100 per cent of 11 cases respectively in Stage Ia, in 85.7 per cent of 21 and in 81.3 per cent of 16 respectively in Stage Ib. Stage I in all: 88.9 per cent of 36 and 88.9 per cent of 27 respectively. Stage II: 67.9 per cent of 28 and 63.6 per cent of 22 cases respectively. Stage III: 0. Total material: 70.8 per cent of 72 and 66.7 per cent of 57 patients respectively.

The following method of treatment has been used: phimosis operation followed by radium treatment (on a mold or with teleradium) that is given greatly protracted or protracted-fractionated. For persistent or recurrent tumor a comparatively conservative amputation of the penis is done or, in a few cases, electrocoagulation is used. The lymphatic regions are always irradiated (*as a rule with teleradium*) whether or not metastases are clinically demonstrated. For persistent, newly formed or recurrent glandular metastases dissection of the groins is done.

This method allows the treatment to be carried out without complications, and the radiosensitivity is rather good. The percentage of cases in which freedom from symptoms has been obtained compares with or surpasses the results observed after more radical treatment methods. Also the functional results are better.

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CARCINOMA OF THE ANAL CANAL*

STATISTICS OF THE FONDATION CURIE, PARIS

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INTRODUCTION

ON READING the literature concerning carcinoma of the anal canal, one is struck by the fact that, as a rule, no clear distinction is made between this and carcinoma of the rectum. The two are usually classified together as one lesion in most of the published works. It is difficult to justify this association, but it may partly be explained by the fact that the lower end of the rectum is almost constantly invaded by carcinoma arising in the anal canal, if it is at all extensive.

Without going into the exact anatomical details, which we consider unnecessary here, we wish to state at the very beginning that the anal canal proper is limited to a very small portion of the digestive tract, averaging about 2 centimeters in length. Carcinoma arising in its wall can therefore remain localized to it only for a very short time. Judging from the extent of most of the tumors in this site which we have treated, it appears certain that the lowest portion of the rectum must have been involved in almost every case.

Despite this, it is important to distinguish between those cases of carcinoma arising primarily in the anal canal and these arising in the rectum, because of the following important properties of anal lesions:

(1) Greater accessibility of the tumor for irradiation.

(2) Its proximity to the anal sphincter which cannot be preserved by surgical treatment of the lesion.

(3) Its histopathological structure. All the lesions of our series were of epithelial origin and therefore considerably more radiosensitive than adenocarcinoma of the rectum.

(4) Rarity with which it results in intrapelvic lymph node metastases which are common in carcinoma of the rectum. These lesions tend more to involve the inguinal lymph nodes.

The study of anal carcinoma as a separate entity is made more difficult still by the rarity of its occurrence. For instance, at the Anti-Cancer Centre of Liège (Belgium) for 4,000 patients its percentage incidence was only 0.45 per cent. Here at the Fondation Curie out of 10,000 patients, only 0.58 per cent had true anal lesions. Furthermore the few statistical analyses which have been published concerning this lesion suffer from the disadvantage that they concern only a small number of cases and even these are not followed up for a sufficiently long period of time (generally one to three years). As far as we could determine, no important five year results have been published. This makes comparison of the various methods of treatment, either radiotherapeutic or surgical, difficult.

This may explain the evident divergence of opinion which exists. For instance Bensaude states, "Radium can cure anal carcinoma in the great majority of cases," whereas Duckerts considers that carcinoma arising in this site carries a much graver prognosis. "In our series" he says, "only 1 case in 26, i.e. 3.8 per cent has responded favorably to treatment" (a five year cure).

We intend to deal with the subject under three principal headings:

I. Results of treatment of carcinoma of the anal canal, 1921–1940.

II. Results of treatment of carcinoma of the anal margin, 1921–1940.

III. Account of some modifications in treatment methods introduced since 1940,

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but which have not been sufficiently long in use to yield proper statistical results.

I. RESULTS OF TREATMENT OF CARCINOMA OF THE ANAL CANAL, 1921–1940

This first part concerns 51 cases of carcinoma of the anal canal treated between 1921 to 1940. Throughout the paper the word cure denotes a patient alive and well five years or more after the treatment.

Among these 51 cases we have obtained 18 cures; 13 of these exceeded the five year limit; varying from a period just over five years to sixteen years and averaging nine years.

The functional results in the 18 five year cures were as follows:

3 cases of complete anal stenosis with 3 colostomies.
3 cases of partial anal stenosis with 3 colostomies.
1 case of slight anal stenosis with 1 colostomy.
11 cases of normal ani all without colostomy.

Analysis of the 33 failures is as follows:

21 cases of failure to sterilize the tumor.
2 cases of recurrence in the lymph node areas; one of these in the pelvic nodes and the other in the inguinal nodes.
3 cases of recurrence of both primary and lymph areas.
1 case of metastasis in the lumbar vertebrae.
4 deaths due to intercurrent disease.
2 patients untraced.

Analysis of these results according to the extent of the lesion: In dealing with this aspect we must take into account both the extent of the primary tumors and that of any lymph node metastasis present.

It is not difficult to determine the circular extent of the primary lesion around the anal canal, but it is more difficult to be precise about its extent upwards into the rectum. But as we have stated before, this involvement of the rectum must occur in most cases, owing to the shortness of the anal canal. For purposes of precise analysis, we have divided tumors invading the rectum into two classes.

(a) Tumors invading the rectum slightly (i.e. less than 5 cm. in length).

(b) Tumors invading the rectum extensively (i.e. more than 5 cm. in length).

The existence of lymph node metastasis can only be determined with certainty by the histopathological examination of specimens removed from patients who have undergone block dissection of the groins, or in those cases in which prolonged and careful clinical observation leaves no doubt as to their presence or absence. However, not many of our patients have had inguinal block dissection performed. In other cases, rapid advance of the primary lesion has caused the death of the patient before a sufficient length of time had elapsed for proper observation of the lymph node areas. These facts have made accurate statistics impossible to obtain. A similar difficulty has arisen in all sites where a routine block dissection has not been performed.

Analysis of results according to extent of primary lesion:

(1) Small lesions of the anal canal which do not completely surround it, but extend more or less widely byond the anal margin on to the perianal skin.

3 cases—2 cures and 1 failure.

The lesion cured in both the cases was a small one.

In the third case the lesion extended far beyond the anal margin onto the perianal skin. The patient died of perianal gangrene, immediately following radium implantation.

(2) Lesions completely limited to the anal canal (i.e., less than 2 cm. in length). In our series none of these cases had lesions completely surrounding the canal; one wall was always found uninvaded at rectal examination.

(3) Lesions involving the rectum slightly (less than 5 cm. in length).

16 cases—6 cures—10 failures.

(4) Lesions invading the rectum extensively (more than 5 cm. in length).

18 cases—4 cures—14 failures.

(5) Lesions with lateral extension into the ischiorectal fossa:

4 cases—no cures—4 failures.

Analysis of lymph node metastasis:

1. Cures with enlarged inguinal nodes.

Twenty-eight of our 51 cases had clinically enlarged inguinal lymph nodes. Treatment was as follows:

(a) Surgical treatment:8 cases

Histopathological examination of the removed specimens revealed:

6 cases with proved metastases (nodes markedly enlarged).

2 cases without metastases (enlargement of the nodes here not marked).

Of the 6 cases with proved metastases:

Two subsequently developed recurrences; 1 of these after five years (primary lesion not sterilized) and the other after two years (primary lesion healed). One died two years afterwards exact cause unknown. One died one year afterwards of jaundice; no evidence of recurrence present.

One patient alive six years later; no information as to local condition.

One of the 2 cases in which the histopathological examination was negative was alive seven years later.

One was alive and well four years later and the other untreated after fifteen months

(b) Treatment by radiotherapy:

7 cases treated; no subsequent evidence of recurrence.

(c) Cases with enlarged lymph nodes observed but not treated.

13 cases, 1 recurrence in the tenth year (primary lesion healed). The others showed no evidence of recurrence.

2. Cases with enlarged pelvic lymph nodes (revealed by rectal examination).

Invasion of the pelvic lymph nodes was found in 5 cases out of 51. In all of these cases the rectum had been invaded by carcinoma. Only 1 of these showed subsequent evidence of carcinoma.

The conclusions we draw from this analysis of the extent of the lesions are as follows.

(1) Concerning the primary lesions: Size is of great prognostic importance. Although the small number of cases in our series does not give us the right to establish percentages, it is sufficiently clear from what is written regarding the extent of the primary lesions that the curability of the tumor depends largely on its extent and therefore on early treatment.

This early treatment has been achieved by certain American authors who practice routine microscopic examination of all anal lesions. Thus Buie has discovered 18 cases of carcinoma not clinically recognized as such (in 951 histopathological examinations).

(2) Concerning the lymph nodes: Conclusions are not so easily drawn. It is obvious that our estimation of the indications of surgery is satisfactory since out of 8 cases operated upon, 6 had microscopically proved metastasis. But it is not possible to draw any conclusion concerning the cases which have undergone radiotherapy. These cases have shown no sign of subsequent recurrence, it is true, but among these cases with clinically enlarged lymph nodes with no active treatment, only 1 developed subsequent lymph node metastasis after ten years.

On the strength of these figures, it seems probable that no treatment of the lymph node areas is required, when the clinical examination does not reveal enlarged nodes or even in the cases where the enlargement is not marked and does not present definite signs of malignancy.

There is another fact which supports this conclusion, namely, that these cases have been followed for long periods of time. For the 36 cases where lymph nodes areas received no treatment, the period of observation ranges from six months to sixteen years and in 10 of these was of more than five years. In all these, only 2 subsequently showed evidence of metastasis.

Taking into account this rarity of lymphatic recurrence, we are then forced to conclude that block dissection of lymph drainage areas is not so imperative as in carcinoma arising in other sites provided the patients are kept under careful observation.

More decisive conclusions than this will be determined only by statistics of a larger number of cases, followed for a longer period of time, e.g. for ten years.

Histopathology and Radiosensitivity.

The results of histopathological examination of the biopsies are as follows:

Differentiated squamous carcinoma—38 cases
Anaplastic carcinoma—13 cases

Two of the anaplastic carcinomas showed areas of cylindromatous development.

The distinction between squamous carcinoma and anaplastic carcinoma is not always definite. The site and the extent of the biopsy taken may affect the pathological report as characteristics of the lesion may change from area to area throughout its extent. Moreover, in one case in which the primary tumor had been classed as anaplastic, the lymph node metastases were found to be squamous in type. We wish to stress the point made by Dr. Gricouroff, who has performed all the histopathological examinations, that the undifferentiated tumors of the anal canal have no connection with basal cell carcinoma of the skin which never give rise to metastatic deposits.

The following figures show the proportion of cases in which complete initial regression was obtained with radiotherapy:

Differentiated squamous carcinoma—18 cases out of 38
Anaplastic carcinoma—10 cases out of 11
(Two untraced cases are excluded)

But when we consider the five year results of treatment according to the extent of the lesions, the proportion of cures in both is almost the same.

So far as we have determined, the percentage of lymph node metastasis in both types is similar. But it must be recalled that our knowledge of the involvement of lymph nodes is very imprecise.

Surgical Treatment.

This question must be considered from several points of view: (1) Comparison of long term surgical and radiotherapeutic results: If anyone could bring forward conclusive statistics in favor of either surgery or radiotherapy, the question of the best treatment would no longer be open to dispute. But such a comparison at present is impossible, as there are no statistics of importance concerning five year results in either field. In all the literature which we have had access to, we have found reports of only 10 five year cures by surgery and 10 by radiotherapy. Even these cannot be translated into percentage figures because nearly all these reports include cases which have not been followed up for five years (see Tables I and II).

TABLE I

SURGICAL CURES OF AT LEAST FIVE YEARS' DURATION

Raiford	(1933)	1 case
Pemberton and Dixon (Mayo Clinic)	(1934)	3 cases
Keyes	(1937)	4 cases
Cattell	(1943)	2 cases
		10 cases

TABLE II

CURES BY RADIOTHERAPY OF AT LEAST FIVE YEARS' DURATION

Gordon-Watson	(1932)	1 case
Binkley	(1938)	1 case
Tucker and Hellwig	(1938)	1 case
Berven	(1939)	4 cases
Kaplan and Rubenfeld	(1940)	1 case
Meland	(1940)	3 cases
		11 cases

(2) Comparison of postoperative and postirradiation complications: Following

perineal amputation of the anal canal rapid healing occurs in most cases and after the first few days the patient has little or no pain. Following radiotherapy the radiation reaction is more unpleasant than this and varies greatly with the dose administered and the sensitivity of the patient to radiation.

(3) The question of colostomy: In choosing between various methods of treatment, is is important to take into consideration how much it means to the patient if a permanent colostomy can be avoided.

Perineal amputation of the anal canal systematically removes the sphincter and leaves the patient either with anal incontinence, or with a colostomy. It is unnecessary to enlarge on the distressing nature of this disability, even when the best care can be obtained for it. Even if the long term results were found to be exactly the same with each method, radiotherapy would have the great advantage that it gives a a chance of cure without a permanent colostomy. Among our 18 five year cures, 11 did not require this operation, and were able to defecate normally afterwards. According to these results given a lesion which is not very advanced, one may hope to preserve normal anal function for the patient by means of radiotherapy.

(4) Enlarged lymph nodes: We have already discussed lymphatic metastasis at this site. It seems that routine treatment of the lymph drainage areas is not as important as in certain cancers at other sites, e.g., the tongue. But we do think, however, that it is necessary to treat the groins whenever the clinical examination reveals enlarged nodes of apparent significance and that complete block dissection is the most effective method of doing this.

(5) Perineal amputation after the failure of radiotherapy: We have employed this procedure in 5 cases at periods varying from one to eleven months following radiation treatment. A perineal amputation of the rectum was performed followed by bilateral block dissection of the inguinal nodes. In one case the posterior vaginal wall was also removed, and in another the uterus and vagina.

Among these 5 patients:

One died of obstructive jaundice one year after operation.

A second died of local recurrence two years after operation.

A third died of lymph node metastasis five years after operation.

A fourth was alive and well five years after operation.

A fifth was alive five years after operation, but the condition of the treated areas was not ascertained.

We have not been able to operate on all the cases in which radiotherapy had apparently failed to effect a cure. Sometimes the extent of the lesions has been too great and we were deterred by the danger of postoperative necrosis.

Lately we have operated on such cases without complications other than delayed healing of the wound. We are proposing, in the future, to give our indications for surgery a wider scope and to operate on all possible cases as soon as it becomes apparent that the lesion has not responded to radiotherapy. Unfortunately, it is difficult to determine exactly when hope of success by radiotherapy must be given up. Several factors must be considered before deciding on operation: histopathologic structure, size of the tumor, and the radiotherapeutic method. Tentatively we have decided that it is advisable to wait at least two months after radiotherapy in any case and then only to decide on surgical intervention if a positive biopsy report is obtained.

Radiotherapeutic Methods. The radiotherapy of these tumors is the least definite of all our treatments. Indeed, it would appear that we are undecided as to the best method to adopt, considering that for our 51 patients treated, 17 different methods of treatment have been tried using one or more of the following radiation devices: radium implantation, surface radium applicator, intracavitary radium teleradium therapy and roentgen therapy. Here is an analysis of the methods used which have yielded five year cures:

Radium implantation alone—2 cases treated, 2 cures.
Radium implantation and surface radium applicator—5 cases treated, 3 cures.
Radium implantation and intracavitary radium —1 case treated, 1 cure.
Radium implantation and teleradium treatment—11 cases treated, 7 cures.

It is not, however, possible to judge the value of the various methods from the above, as the tumors treated were not comparable. For instance, even though radium implantation has been used alone, and with success, in 2 cases, one must attribute this largely to the fact that those 2 patients had small lesions, and it is therefore not reasonable to conclude that radium implantation is the best method.

We have altered our methods between 1922 and 1940. Teleradium therapy has gradually supplanted local radium. Radium implantation has not been recently employed to give such large doses as in its early days. These changes were determined by the necessity to avoid delivering a dose of radiation to the anal sphincter which would cause sclerosis of the musculature and also to increase the dose in the deeper tissues without overdosing the superficial structures. Overdosage of the superficial tissues seems to have been one of the principal factors in producing the necroses which have occurred in our series.

Complications following radiotherapy.

(a) Radionecrosis: Among the 51 patients treated, 8 subsequently suffered from radionecrosis as follows:

One patient suffered a severe necrosis which persisted for thirteen years. This patient who was treated in 1922 received an excessive dose of radiation.

Three patients suffered slight necrosis which eventually healed and remained cured at the end of five years.

Four patients suffered radionecrosis plus recurrence.

Radionecrosis was much more common at the beginning of our series, but has become gradually rare. Six of the necroses occurred among the patients treated 1921–1931, whereas only 2 cases occurred among the patients treated 1932–1940. Evidence that the cause of necrosis in these cases was overdosage is furnished by the fact that no necrosis has been observed when the radium dose delivered was under 18 millicuries-destroyed. Stricture was a common sequel to necrosis. In one case only necrosis was not followed by stricture; but in that case, the necrosis was a small one.

(b) Strictures: Among the 18 five year cures, stenosis or stricture occurred in 7 cases. Four of these were of gradual onset due to progressive fibrosis of the perianal tissues and 3 followed necrosis.

(c) Complications of infection: We have had one very severe case of infection in a patient, aged seventy-one, suffering from an advanced carcinoma widely involving the perianal skin. Teleradium treatment had been carried out without incident, but during radium implantation the patient developed an infectious gangrene of the perianal tissues, which proved fatal in a few days.

Prognosis and analysis of cause of failure. Thirty-five per cent of all our cases treated have resulted in five year cures. The extent of the primary tumor has greatly influenced the prognosis in these cases.

The proportion of cures was three times as great in those cases where the primary tumor did not completely surround the anal canal, and was limited to its walls as in those where the rectum was perceptibly involved.

No success was obtained when the primary tumor completely encircled the anal canal, nor in those lesions which involved the ischiorectal fossa.

Extension to the inguinal glands does not seem to be of primary importance in prognosis. Among all the cases, whether treated or not, we have noted only 3 cases where death was caused by the lymph node metastasis alone.

It does not seem either, that the histopathological picture gives any indication

of the remote prognosis. At first sight there have been three times as many cures among the anaplastic carcinomas as among the differentiated types, but when the size of the primary lesion is taken into account, there does not seem to be much difference between the two types.

In certain of the cases where the treatment failed to cure the patient, the causes of failure were clear:

In 6 cases treatment was not completed owing to complications, e.g., gangrene, embolus, etc.
In 3 cases the patient died of lymph node metastasis.
In 1 case failure was due to a metastasis in the lumbar vertebrae.
In 1 case failure was due to intercurrent disease.

From this it would appear that there were fewer *local* failures of cure than the five year figures show.

Several failures followed underdosage or badly arranged dosage distribution within the tumor. For instance, one lesion 4 cm. in height was treated by radium implantation followed by a surface radium applicator of R. S. D., 1 cm., i.e. the type usually used for superficial cutaneous lesions.

II. CARCINOMA OF THE ANAL MARGIN, 1921–1940

In our series, there have only been 6 cases of carcinoma strictly limited to the anal margin, between 1921–1940.

Five were cases of squamous carcinoma, and one a basal cell carcinoma.

We have treated these patients as follows:

2 cases by radium implantation.
1 case by radium implantation, and a radium surface applicator.
1 case by radium implantation, radium surface applicator followed by excision.
1 case by interstitial radium and intracavitary radium.
1 case by interstitial radium and teleradium.

Of these cases 3 had inguinal block dissection performed and in every case the lymph nodes were found to be invaded by the carcinoma.

The results in these 6 cases were as follows:

3 patients alive and well at the end of five years.
1 death from intercurrent disease after one year.
1 death due to local and lymph node recurrence.
1 patient alive thirteen years after treatment without evidence of recurrence, but suffering from painful unhealed perineal necrosis.

Like Cattell, we think the only point worth noting about carcinoma at this site is the frequency with which the lymph nodes are invaded. But the small number of cases in the series prevents definite conclusions being drawn.

III. CHANGES IN TREATMENT METHODS SINCE 1940

Since 1940, we have been able to apply new principles to the treatment of carcinoma of the anal canal, owing to the possibility of employing supervoltage therapy and low voltage therapy.

(a) *Supervoltage Therapy.* Since 1940 in the treatment of this disease, surface radium applicator and radium implantation have been replaced by deep roentgen therapy on our new 500 kv. apparatus which was installed about this time.

We were influenced in this by the following considerations:

(1) The use of roentgen rays, generated at a higher tension than before, enabled us to deliver to the deeper parts of the tumor a better depth dose. Using an anterior field and a posterior sacrococcygeal field, the dose at a point 5 cm. from the anal orifice, within the rectum, was found to be increased from 33 per cent at 200 kv. to 48 per cent at 500 kv.

(2) The dose distribution within the tumor was found to be more homogeneous than that obtained by radium implantation or surface applicator. We hope that this will give us a higher cure rate and avoid necrosis of the superficial tissues due to overdosage.

(3) The possibility of reducing the occurrence of stricture by abandoning interstitial radium, which when implanted in the sphincter or its neighborhood, caused what we might call "sleeves of fibrosis" around the site of each container.

We cannot, at present, give any details of the results obtained by this method, because the follow up time for these cases is under five years. Eleven patients have been treated in this manner by Dr. Courtial.

(b) *Short Distance Low Voltage Therapy, i.e. "Contact Roentgen Therapy."* This type of treatment has been used by Chaoul for over ten years. His success with this method in carcinoma of the rectum is well known. But Chaoul does not refer either in his articles or in his recent book, "Nahbestrahlung," to the use of this method for carcinoma of the anal canal.

With the Philips apparatus of this type which we have in use at present, the only lesions which appear to be amenable to this technique are those of small size confined to the anal canal. Infiltrating or extensive lesions require multiple fields, and this technique carries the risk of overdosage due to intersection of fields, followed by necrosis or of underdosage resulting in failure to sterilize the tumor.

The technique for irradiation of the anal canal appears to be more complex than that for the rectum. It is easy to introduce the Philips tube into the ampulla of the rectum, following caudal anesthesia, or even without any preparation. But to irradiate the mucous membrane of the anal canal properly, it is preferable to dilate the canal under intravenous anesthesia, and to introduce the tube while the anus is dilated. The use of a tube in which the rays are emitted through a lateral window, or of a tube with a conical anode emitting roentgen rays over all its surface, would simplify the technique greatly, and avoid the anesthesia and dilatation.

CONCLUSIONS

(1) Carcinoma of anal canal is a radiosensitive tumor. This is shown by the eighteen five year cures in our series of fifty-one cases (35 per cent).

(2) Radiation is the only treatment which gives a chance of avoiding permanent colostomy.

(3) Comparison of radiotherapeutic and surgical results is impossible for want of extensive five year statistics.

(4) The number of failures following radiotherapy is still large. But if the treatment were carried out earlier when the lesions were still small, the number of cures would greatly be increased. *For the eleven cases where the primary lesion did not extend beyond the limits of the anal canal at treatment seven were cured.* It is curious that such painful lesions causing functional disorders at an early stage should not come to treatment until they are advanced. This is not always the fault of the patient. Routine microscopic examination seems to be of importance in an early diagnosis, since it has enabled Buie, for instance, to detect several cases of early carcinoma which had not been clinically diagnosed. It is also reasonable to suppose that the recent improvements in technique ought to give rise to better results.

The future will show whether we have been correct in abandoning radium implantation in favor of contact roentgen therapy for small lesions and supervoltage roentgen therapy for larger lesions extending outside the anal canal.

In case of failure following radiotherapy, perineal amputation of the rectum must take a greater part than hitherto. We must take into account when planning our treatment, without sacrificing any of its efficacy, that contact roentgen therapy does not affect the subsequent surgical operation, whereas operation following deep roentgen therapy carries a greater risk of necrosis on this account.

Finally, we feel that the hope of preserving a normal anus, the results that we have obtained in the past, and the technical improvements, which are at present in operation, justify the use of irradiation as the primary treatment. Subsequently, if this fails, surgical removal can be carried out, provided the previous radiotherapy has not made operation impossible.

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APPLICATIONS OF ARTIFICIALLY RADIOACTIVE ISOTOPES IN THERAPY*

I. COBALT^{60}

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THE announcement[1] of the availability in large quantities of artificially radioactive isotopes of many of the elements, either generated by exposure to the high neutron fluxes in a nuclear reactor (pile) or resulting as by-products of controlled nuclear fission in the production of plutonium, ushered in a new era in medical science. New tools have been provided in abundance to challenge the ingenuity of the investigator in the application of them both in research and in therapy. A perusal of the lists in the publication revealed that several of the radioisotopes have properties which invite investigation of them as sources of ionizing radiation that, for one reason or another, might be used advantageously in therapy to supplement or to supplant radium and radon.

In order to augment the broad program in progress at the Ohio State University College of Medicine during the past eight years in which artificial radioisotopes have played an increasingly important role both in therapy and in fundamental research, it was decided to survey systematically several of the radioactive isotopes now at hand in adequate amounts and activities for the first time, to discover those which will prove to be the most useful directly in therapy. Cobalt^{60} was chosen for the initial investigation principally because its relatively long half-life of more than five years would facilitate the accumulation of experience with the new sources of ionizing radiation. It was originally planned to review the pertinent physical properties of the radioisotope and to present the advantages of the form in which we had found it to be suitable after a time when we had had the opportunity to gain at least preliminary clinical experience with it to report simultaneously.† But the wide interest created recently by the disclosure to the Press by the Chairman of the United States Atomic Energy Commission that research was in progress at several universities, including The Ohio State University, on possible therapeutic applications of radiocobalt, makes it appear desirable at this time to summarize the physical properties together with our experience with the isotope thus far.

PHYSICAL PROPERTIES OF COBALT^{60}

Cobalt^{60} can be generated conveniently by the reactions:

$$(1)\qquad {}_{27}Co^{59} \xrightarrow[\text{(Nuclear Reactor)}]{n,\ \gamma} {}_{27}Co^{60}$$

$$(2)\qquad {}_{27}Co^{59} \xrightarrow[\text{(Cyclotron)}]{d,\ p} {}_{27}Co^{60}$$

In the first reaction, a neutron is captured by the nucleus of the stable isotope of cobalt of mass 59,[2,3,4,5,7,9] which comprises all of the natural element[6] to convert it to Co^{60} with the simultaneous emission of a gamma photon in the process.[2] Since a nuclear reactor is an excellent source of controlled high neutron fluxes, this nuclear reaction goes very efficiently when cobalt is placed within it. In the second reaction, the neutron from a deuteron bombarding

† Professor Joseph L. Morton, who has recently resumed his duties in the Radiology Department of The Ohio State University after a leave of absence, will direct the studies at this institution leading to the clinical evaluation of the usefulness of Co^{60} in therapy. His encouragement largely led to the initiation of these early studies.

* Presented at the Thirtieth Annual Meeting, American Radium Society, Chicago, Ill., June 20–22, 1948.

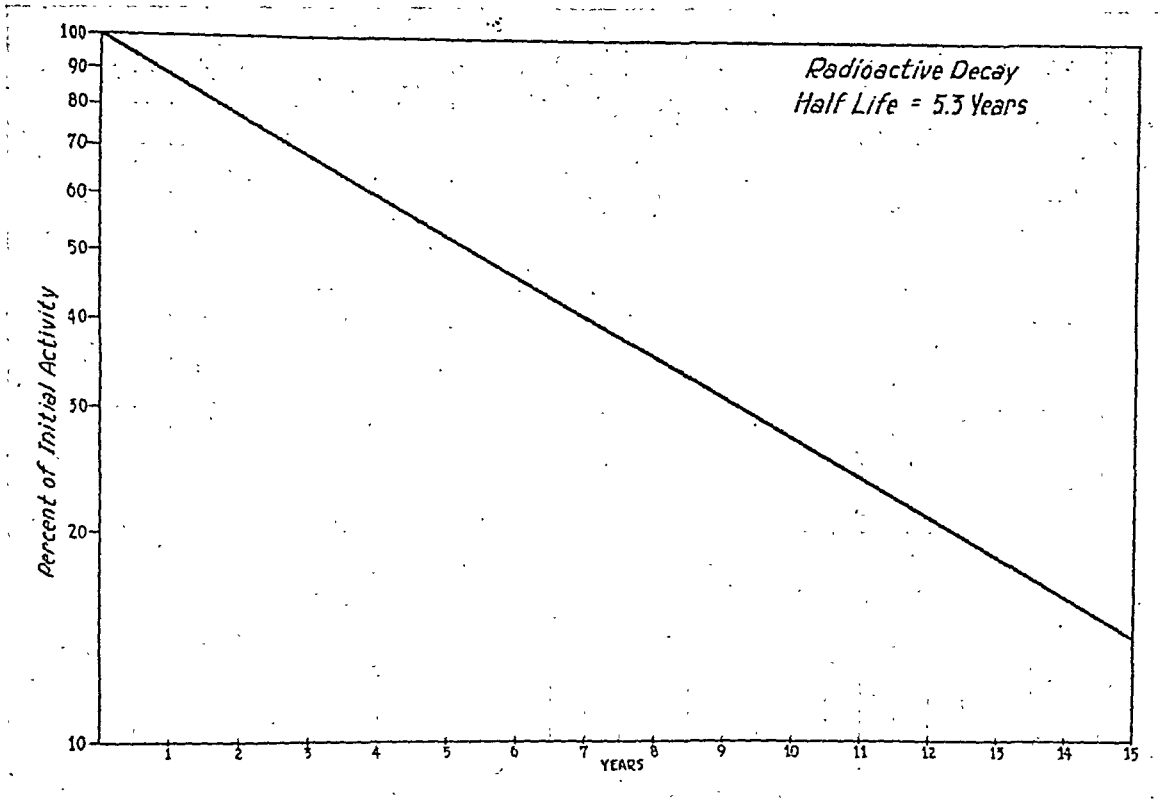


Fig. 1. Decay curve for a radioisotope with half-life of 5.3 years.

Co^{59} in a cyclotron is captured by the nucleus and the proton is rejected.[7,8,9] In both instances isomeric radioactive nuclei with half-lives of 10.7 minutes and 5.3 years may be formed.[7,8] Obviously the short-lived isomer is of no importance in therapy. Only a small part of Co^{60} generated in a nuclear reactor is the 10.7 minute isomer and probably most of that which does form disintegrates by isomeric transition to the long-lived isotope.[7,8,9] In Figure 1 there appears the radioactive decay curve for an isotope with a half-life of 5.3 years* and in Table 1 are listed the calculated percentages of the initial activities remaining at monthly intervals together with the reciprocals. Figure 2 depicts the disintegration scheme of the long-lived Co^{60} isotope according to Professor Robley D. Evans.[11] It is seen from this that the emission of an

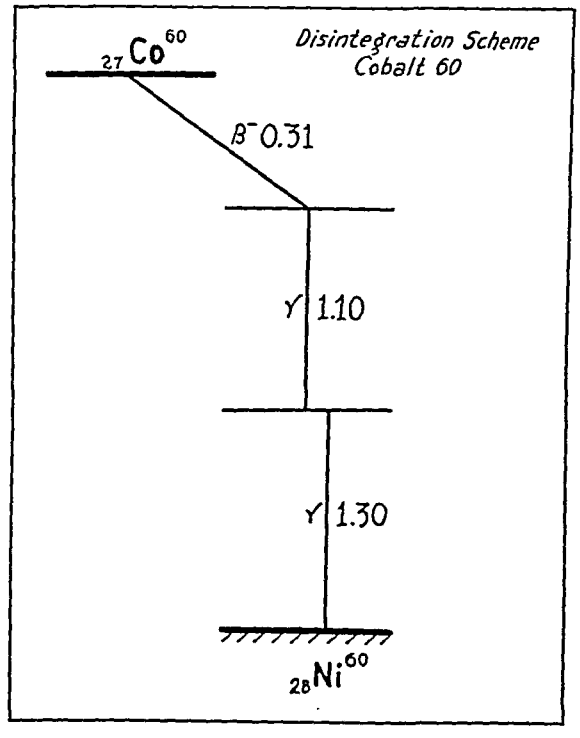


Fig. 2. Disintegration scheme of long-lived cobalt[60] (after R. D. Evans).

* Dr. L. F. Curtiss recently stated at a meeting of the Biology Division of Argonne National Laboratory that the 5.3 year half-life value for the long period Co^{60} isotope is proving to be accurate to within 1–2 per cent on the basis of early reports from two different laboratories where it is being checked.

TABLE I

PERCENTAGES AND RECIPROCALS OF THE INITIAL ACTIVITY REMAINING AT MONTHLY INTERVALS CALCULATED FOR A RADIOISOTOPE WITH HALF-LIFE = 5.3 YEARS

Time Yr.	Mo.	Per Cent Remaining	Reciprocals	Time Yr.	Mo.	Per Cent Remaining	Reciprocals	Time Yr.	Mo.	Per Cent Remaining	Reciprocals
	0	100.00	1.000	3	9	61.23	1.633	9	0	30.82	3.244
	1	98.92	1.011		10	60.55	1.651		2	30.15	3.316
	2	97.83	1.022		11	59.91	1.669		4	29.50	3.389
	3	96.78	1.033	4	0	59.27	1.687		6	28.86	3.465
	4	95.73	1.044		1	58.61	1.706		8	28.24	3.541
	5	94.70	1.055		2	57.98	1.724		10	27.63	3.619
	6	93.67	1.067		3	57.35	1.743	10	0	27.03	3.699
	7	92.66	1.079		4	56.72	1.763		2	26.45	3.780
	8	91.64	1.091		5	56.11	1.782		4	25.88	3.863
	9	90.66	1.103		6	55.51	1.801		6	25.32	3.949
	10	89.68	1.115		7	54.90	1.821		8	24.78	4.035
	11	88.70	1.127		8	54.31	1.841		10	24.25	4.123
1	0	87.74	1.139		9	53.72	1.861	11	0	23.72	4.215
	1	86.80	1.152		10	53.14	1.881		2	23.21	4.308
	2	85.85	1.164		11	52.56	1.902		4	22.71	4.403
	3	84.91	1.177	5	0	52.00	1.923		6	22.22	4.500
	4	84.00	1.190		1	51.42	1.944		8	21.74	4.599
	5	83.06	1.203		2	50.87	1.965		10	21.28	4.699
	6	82.19	1.216		3	50.32	1.987	12	0	20.81	4.805
	7	81.30	1.230		4	49.77	2.009		6	19.50	5.128
	8	80.40	1.243		5	49.23	2.031	13	0	18.26	5.476
	9	79.53	1.257		6	48.71	2.052		6	17.10	5.847
	10	78.69	1.270		7	48.18	2.075	14	0	16.02	6.242
	11	77.81	1.285		8	47.65	2.098		6	15.01	6.662
2	0	76.99	1.298		9	47.14	2.121	15	0	14.06	7.112
	1	76.14	1.313		10	46.62	2.145		6	13.17	7.593
	2	75.31	1.327		11	46.12	2.168	16	0	12.33	8.110
	3	74.50	1.342	6	0	45.62	2.192		6	11.55	8.658
	4	73.70	1.356		2	44.64	2.240	17	0	10.82	9.242
	5	72.91	1.371		4	43.67	2.289		6	10.14	9.861
	6	72.11	1.386		6	42.74	2.339	18	0	9.49	10.537
	7	71.33	1.401		8	41.81	2.391		6	8.89	11.24
	8	70.55	1.417		10	40.91	2.444	19	0	8.33	12.00
	9	69.79	1.432	7	0	40.03	2.498		6	7.80	12.82
	10	69.05	1.448		2	39.16	2.553	20	0	7.31	13.67
	11	68.28	1.464		4	38.32	2.609		6	6.85	14.59
3	0	67.54	1.480		6	37.50	2.666	21	0	6.41	15.60
	1	66.81	1.496		8	36.68	2.726	22	0	5.64	17.73
	2	66.09	1.513		10	35.89	2.786	23	0	4.94	20.24
	3	65.37	1.529	8	0	35.12	2.847	24	0	4.33	23.09
	4	64.66	1.546		2	34.36	2.910	25	0	3.80	26.31
	5	63.96	1.563		4	33.62	2.974	30	0	1.98	50.50
	6	63.27	1.580		6	32.90	3.039	35	0	1.03	97.08
	7	62.57	1.598		8	32.19	3.106	40	0	0.535	186.8
	8	61.90	1.615		10	31.49	3.175	50	0	0.145	690.0

electron with $E_{max.} = 0.31$ mev. is followed by two gamma photons in cascade with energies of 1.10 and 1.30 mev. respectively.[9,10] In Figure 3 is shown the absorption of the gamma radiation by lead. The half-thickness is found to be 0.44 inch corresponding to a photon energy of about 1.35 mev.

APPLICATORS CONTAINING COBALT[60]

Elemental cobalt as it is usually obtained is a hard, brittle, and highly magnetic metal with a melting point of 1,480° C. and a density of 8.9. It is available commercially in the form of rondels at a few dollars a pound. These proved to be so hard and difficult to machine that an alloy was sought which would be more workable and the other component of which would not emit significant amounts of undesirable radiation after bombardment in the nuclear reactor. An inexpensive alloy composed of 45 per cent cobalt and 55 per cent nickel* known as "cobanic" is proving to be highly

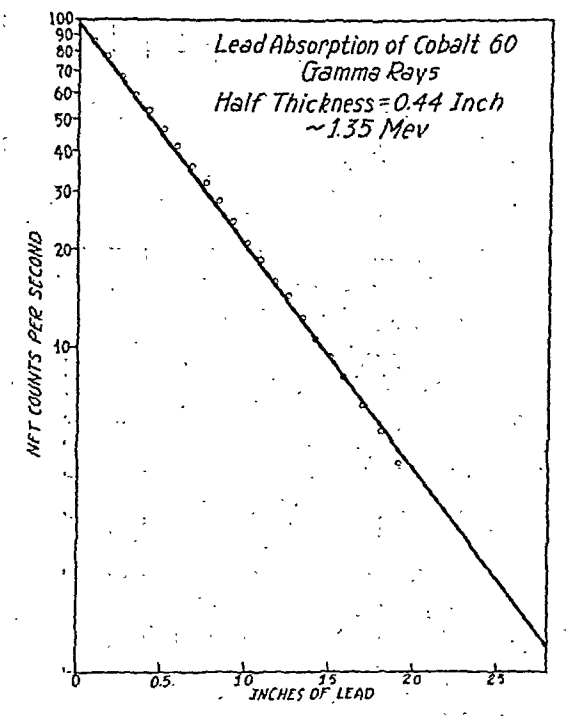


FIG. 3. Absorption of gamma radiation emitted from cobalt[60] by lead.

satisfactory for our purpose. Cobanic has been obtained† in the form of wire in several diameters. The wire is hard and stiff, though it can be machined fairly readily in the temper at hand. A wire 0.040 inch in diameter broke only after more than a dozen sharp 90° bends. It is highly inert chemically as evidenced by essentially no

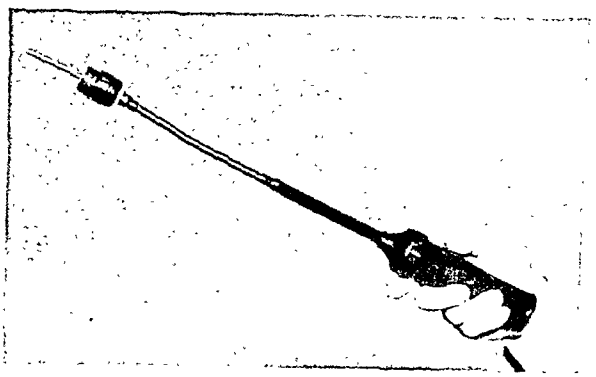


FIG. 4. Battery-operated electromagnet with semi-flexible shank for operations around shields.

observable change in the surfaces of pieces immersed in 0.1 N hydrochloric acid and 0.1 N sodium hydroxide respectively for the past year. It is strongly magnetic and we have found it most convenient to handle it during many manipulations with an electromagnet* both before and after irradiation in the pile. A very useful magnet attached in place of the bulb on the end of a long probe-type flashlight and operated by two small dry-cells is shown in Figure 4.‡ The shank is semi-flexible and can be bent to work around shields. The components of a piece of cobanic wire were separated chemically§ after activation and it was found that any radionickel generated during the bombardment does not contribute significantly to the total radioactivity emitted by the piece of wire.

We have found it convenient to cut cobanic wire 1 millimeter (18 gauge, 0.040 inch) in diameter into cylinders 1 centimeter long in the apparatus shown in Figure 5¶ which is readily adjustable both

* Suggested by Dr. Paul C. Aebersold, Chief of Isotopes Distribution, Atomic Energy Commission, Oak Ridge, Tennessee. His cooperation has been most generous and is much appreciated.

† "Cobanic" wire was kindly furnished in several sizes by The Wilbur B. Driver Company, Newark, N. J.

‡ Designed and constructed by Mr. P. E. Weiler, Department of Physics, The Ohio State University.

§ Separated by Mr. Harmon L. Finston, Department of Chemistry, The Ohio State University.

¶ Designed and constructed by Mr. Carl McWhirt, *machinist* in the Department of Physics, The Ohio State University.

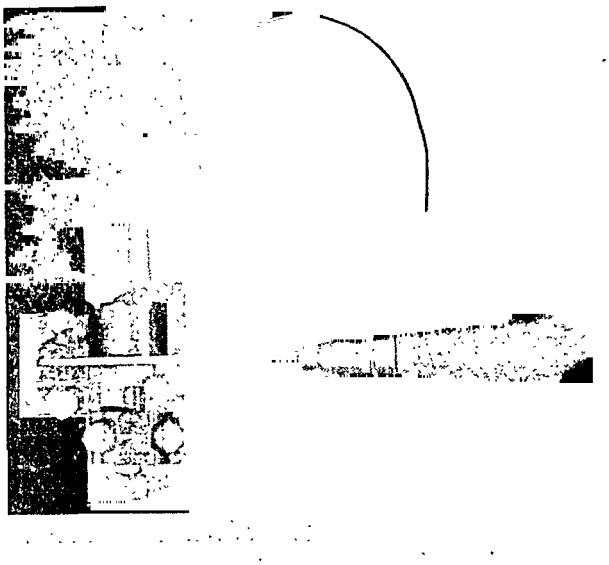


FIG. 5. Cutter adjustable for length of cut and diameter of wire.

for length of cut and diameter of wire. The cylinders made in this manner are remarkably constant in weight, 66.66±0.30 milligrams each; and it is essential that this be the case for the sake of uniformity, since we find that the amount of radioactivity present in the cylinders after exposure to the neutrons in the nuclear reactor is proportional to the mass within a few per cent, when the diameters remain constant. It is a simple matter to weigh the cylinders and select those which fall within the desired limits. Each cylinder is inspected with a low-power lens and any which show burrs are either rejected or the burrs are scuffed off with fine emery cloth. In this way it is an easy task for one to prepare and select a hundred or more of the cylinders in a few hours.

After irradiation in the Oak Ridge nuclear reactor for about a month the above cylinders exhibit a gamma-ray activity approximately equivalent to that emitted by 1.0–1.5 milligrams of radium. A needle about 3 centimeters long and weighing 193 milligrams which was made from cobanic wire 1 millimeter in diameter, was found last November to emit gamma radiation equivalent to that from 4.08 milligrams of radium when the gold leaf electroscope was surrounded by 1 centimeter of lead, and showed 2.97 milliroentgens per hour at 1 meter (mrhm).* This activity is suitable for many clinical applications. If one wished it to be doubled, he would have merely to request that the time of exposure in the nuclear reactor be twice as long. Or, if the requirements were that the diameter of the wire should be less but the activity per unit length should remain unchanged approximately, the irradiation time should be increased inversely with the decreased mass of cobalt per unit of length. The converse of this principle was applied when some cylindrical slugs 1 centimeter long and weighing 1.445 grams each were cut from cobanic wire 4.6 millimeters (5 gauge, 0.185 inch) in diameter. After these were irradiated along with the 1 millimeter cylinders above in the nuclear reactor at Oak Ridge for a month, the activities were found to be 18.6 mrhm and 1.12 mrhm respectively, based on the standardized needle described above. The ratio of activities is 16.6 whereas the weight ratio is 21.7. The variation from proportionality may be accounted for on the basis of the large cross-section of cobalt for slow neutrons[12] which might be expected to result in some "shading" of the nuclei from neutrons within a relatively thick piece of the alloy by the cobalt nuclei nearer to the surface. Self-absorption of the gamma photons by the thicker pieces could also account for some of the observed lack of proportionality. Still a third way in which the amount of Co^{60} present might be varied within limits, in those cases in which it was desirable that the diameter or mass of an applicator and the time of irradiation in the nuclear reactor should remain constant, would be by increasing or decreasing the proportion of cobalt in the alloy.

Figure 6 is a photograph showing two of the large slugs and five of the small cylinders described above, together with a threaded 3 centimeter cobanic needle and one-cell and two-cell length gold alloy needle filters which are commonly employed with radium to absorb most of the high energy beta particles emitted. We

* These values were kindly determined by Dr. L. F. Curtiss at the National Bureau of Standards.

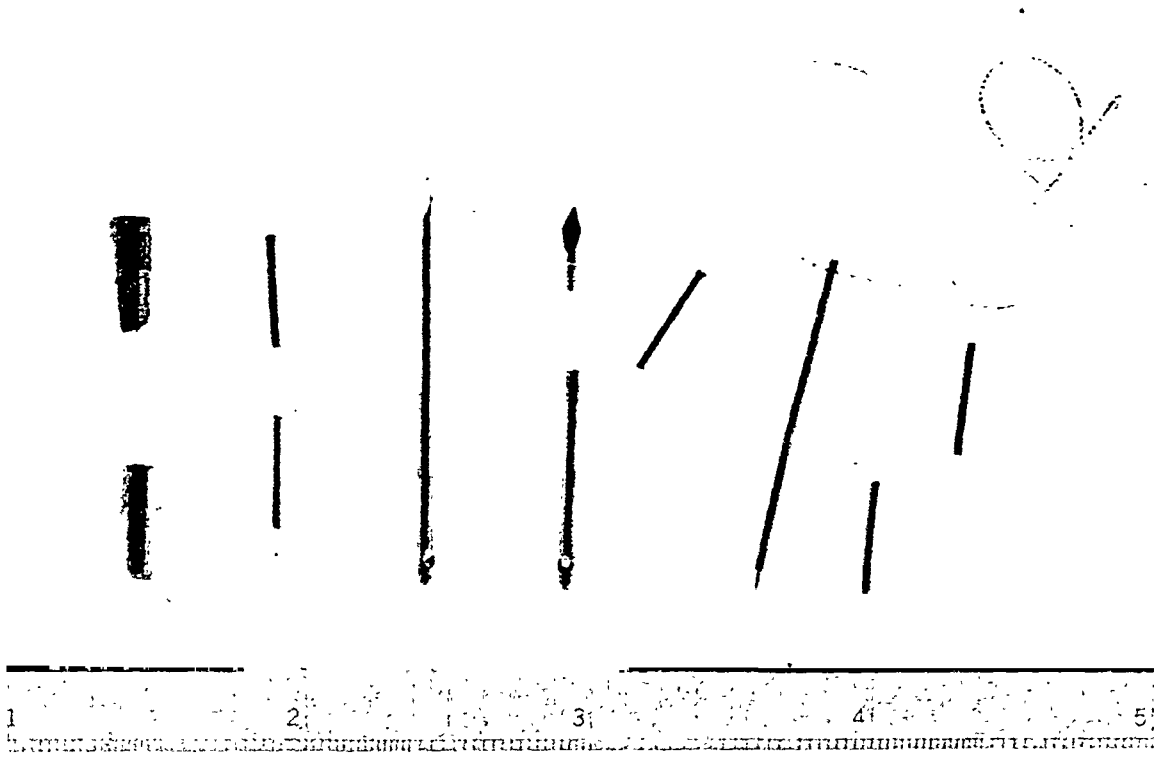


Fig. 6. Cobanic slugs, cylinders, and needle with one-cell and two-cell gold-alloy sheath needles.

have found it convenient at this stage of development to use the gold filters in our early studies to absorb the 0.31 mev. (maximum) beta particles emitted by the long-lived $Co.^{60}$ That this is necessary in order to minimize periacicular necrosis is demonstrated in Figure 7 which is a radioautograph of a radioactive cobanic needle 4 centimeters long over each end of which was slipped one of the one-cell length gold filters before placing it on the emulsion of a lantern slide for about five minutes. It is obvious that the greater density in the unshielded central portion is probably due to the beta particles which were removed by the gold alloy filters covering the ends.

The use of gold or platinum or other metals of high atomic number as filters to remove beta particles is not optimally advantageous as was clearly shown in the studies by Quimby, Marinelli and Blady,[13] and others. They found that the number of secondary electrons resulting from the gamma rays from radium traversing various filters was a minimum when the filters were made up of elements of intermediate atomic number, particularly in the range 26–50 which includes among others, iron, cobalt, nickel, copper, zinc, silver, and tin. It is anticipated that one of the foremost advantages of $cobalt^{60}$ over radium for gamma-ray therapy will prove to be the comparatively low maximum energy of the beta particles emitted, only 0.31 mev., as

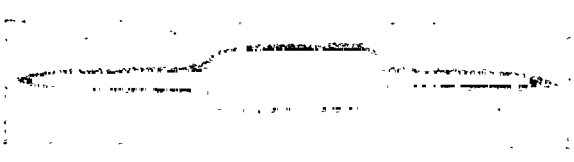


Fig. 7. Radioautograph of 4 centimeter radioactive needle containing $cobalt^{60}$ with gold-alloy sheath on each end to filter out the beta particles.

compared with maximal energies about ten times as great for beta particles given off by some of the radioactive disintegration products of radium. Because their energies are so low the beta particles can easily be removed by thin, strong, and inexpensive monel metal, stainless steel, or other filters composed of elements of intermediate atomic number. In this respect as well as the other properties it possesses as described previously, cobanic alloy itself should be very suitable material from which to make filters. It would have the advantage over many other alloys because it is strongly magnetic so that non-radioactive cobanic filters loaded with the radioactive cobanic could also be handled conveniently and safely with the electromagnet. It is necessary to use gold or platinum filters with radium, at least in large part, because the beta particles present have such high energies that they are not removed completely by thicknesses of lighter elements consistent with practicable needle diameters. In addition to the stainless steel and monel filters which we are now developing, experiments are in progress designed to electroplate about 0.1 millimeter of pure nickel on pointed and eyed cobanic needles such as the threaded needle shown in Figure 6. Calculations indicate that this thickness of nickel should be about sufficient to absorb completely all beta particles with energies of 0.31 mev. or less. The electroplating will be done before irradiation in order that the radioactive needles only 1.2 millimeters in diameter will come from the pile with filters permanently attached and ready for threading. If it were desirable, the diameter could be made even less and the activity per unit of length remain unchanged provided that the time of irradiation in the nuclear reactor were appropriately lengthened.

DISCUSSION

The essentially homogeneous gamma rays, 1.1 and 1.3 mev., emitted by Co^{60} should prove to be particularly advantageous in "telecobalt" installations. Because the isotope can be generated readily in any desired quantities and at moderate cost, the way is now open for this method of application to be come more widely applied in this country, particularly in the larger treatment centers. For large bone lesions the homogeneous high energy photons are expected to prove especially useful in comparison with the heterogeneous gamma rays emitted by radium and its disintegration products because the absorption and scattering will be more uniform.[14]

Besides the numerous advantages of cobalt^{60} over radium described above, additional ones might be listed: 1. There are no gaseous radioactive daughters and leakage is therefore impossible. 2. Because of the properties of alloys containing cobalt which are suitable for irradiation, breakage is almost completely eliminated. Moreover, if it should occur, the pieces could be recovered with no danger of loss by solution and the resultant dangers of lodgment in bones as in the case of radium. If a soluble salt of radiocobalt were present in the broken applicator for some reason, any which did dissolve would be eliminated quickly in the urine. 3. Cobalt alloys can be machined easily to any desired shape before irradiation, thus eliminating the problems and dangers associated with the uniform loading and sealing of radium in applicators. 4. If it proves feasible to prepare needles and other applicators incorporating a permanently attached electroplated nickel absorber for the soft radiocobalt beta particles, these may then be bent readily to fit lesions of different shapes.

The chief disadvantage of cobalt^{60} over radium is, obviously, the relatively short half-life of only 5.3 years compared with 1,590 years for radium. For this reason comparisons of relative costs, especially on a long-term basis, are largely meaningless. In this respect one must consider the possibility that applicators containing Co^{60} could be irradiated further, or "warmed-up" so to speak, in a nuclear reactor whenever it becomes desirable to increase the activity or to restore the waning activity due to decay.

The radiotherapist who uses cobalt^{60} will

be largely compensated for the effort he must expend in the frequent re-evaluation of his applicators, by the presence in his stock at all times after the first few acquisitions, of several different strengths from weak to strong, so that he can apply them to best advantage in formulating the Paterson-Parker patterns[15,16,17] to irradiate individual lesions most effectively. This flexibility will be especially helpful in those departments which have radiation physicists on the staff and instruments suitable for making the measurements frequently.

It hardly needs emphasis that applicators emitting photons with a half-thickness in lead of 0.44 inch must be handled with great care and with full cognizance of the possible dangers involved. In this respect the shielding problem so far as the gamma radiation is concerned is essentially the same as that encountered with radium.

It is a pleasure to express my gratitude to Professor M. L. Pool of the Physics Department for many helpful suggestions and criticisms.

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CANCER DETECTION CENTERS*

THEIR ROLE IN CANCER CONTROL

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THE early diagnosis of cancer has been neglected. The enormity of the intellectual effort and the scientific problems involved in the successful treatment of cancer have, in the past, so captivated the interest of physicians that but little attention, until recent years, has been paid to the possibilities for the early diagnosis of cancer. It is, of course, a fact well established that the earlier in the course of the disease a patient with cancer is treated the better are the chances of effecting a cure. This being true the matter of the early diagnosis of cancer assumes an importance at least equal to the problem of its treatment. It is likewise true that once such symptomatic manifestations of cancer as tumefaction, ulceration, hemorrhage or pain impress themselves upon the consciousness of the patient—and it is not until then that the patient, ordinarily, will consult the physician—the cancer may already be incurable. The next logical step is, therefore, the attempt to find cancer in the incipient stage of the disease; that is, before symptoms of the disease have impressed themselves upon the consciousness of the patient. This is the stage which already has been reached by case finding methods in tuberculosis control and this is the stage in cancer control which the cancer detection center program now seeks to attain.

Cancers of certain organs,—the skin, mouth, breasts, uterus and rectum, are readily demonstrable by simple inspection or palpation; cancers of these organs are readily accessible to surgical extirpation or the tissues in which they appear are tolerant to curative irradiation. These, therefore, are the cancers which, because of relative ease of diagnosis, surgical accessibility and tolerance of tumor bed to irradiation, might properly be called the curable cancers and yet the curability of any one group of these cancers, with the exception of cancers of the skin and lip, does not exceed, at present, 35 per cent. If, then, more patients with these so-called curable cancers are to survive, then these cancers, and likewise cancers of other organs, must be found in their incipient stages,—in the stages when, ideally, the curability might be 100, not 35, per cent.

In the absence of a serological or other specific test for either the diagnosis or exclusion of cancer the only case finding method which can be employed is the exhaustive clinical examination of individuals presumably well but desirous of submitting or willing to submit to such examination.

It is these concepts upon which the cancer detection center program is based.

These, or similar concepts, must have been comprehended by L'Esperance[7] when she founded the Strang Cancer Prevention Clinic of the New York Infirmary for Women and Children in 1937 and extended these activities to Memorial Hospital in 1940. Similar concepts must have guided Macfarlane[8] and the group working with her when the Cancer Prevention Clinic in the Women's Medical College of Pennsylvania was founded in 1938. It is interesting to point out that official sanction was given to such a program that long ago by organized medicine as the early work of the Macfarlane clinic was made possible in part by a grant from the Committee on Scientific Research of the American Medical Association. Similar concepts guided Webster[13,14] and the group working with her in founding

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the Cancer Prevention Clinic in the Women's and Children's Hospital in Chicago in 1943. The first large-scale, community-wide effort came, as the result of the interest aroused in these concepts and the impetus given this program by Macfarlane and her group, in 1944 with the establishment, with the approval and under the coordination of the Academy of Medicine of Philadelphia, in the five teaching hospitals in Philadelphia of a series of "clinics" for the conservation of health. Financial support has been given these Health Maintenance-Cancer Prevention Clinics by the Donner Foundation; their number has since grown to ten or more; and their activities and experience have been given wide publicity by their executive secretary Mildred W. S. Schram.[12]

In 1945 the Council on Medical Service and Public Relations of the American Medical Association laid down some rules and objectives for such centers.[11] The clinic or center, as we now prefer to call it, was defined in the following terms: "A cancer detection, cancer prevention, well person clinic is designed to detect abnormalities not producing symptoms sufficient to send the patient to the doctor. These clinics do not diagnose or treat diseases." The Council further recommended that "no such clinics shall be established in any community without the approval of the county medical society." The American College of Radiology approved the cancer detection center program in February, 1946[10] and the American College of Surgeons resolved to inaugurate a program for the survey and approval of cancer detection centers at its meeting in Cleveland in December, 1946.[4]

This concept of the examination of the apparently well for the express purpose of discovering unsuspected cancer has gained wide acceptance in just the past few years and there are now some 120 such centers in twenty-seven states.[3] Sixty-six of these centers, or more than half, are, however, located in only five states. The American Cancer Society has, of course, figured prominently in fostering this concept, in encouraging its wide acceptance, and in financing the detection center programs, the American Cancer Society probably having given financial aid to all of these centers with the exception of the Strang Cancer Prevention Clinics in New York and the Health Maintenance-Cancer Prevention Clinics in Philadelphia.

The interest of organized medicine in Cleveland in a cancer detection center program at the beginning of 1945 was only passive. Active interest was, however, stimulated by the lay members of the Cuyahoga County Division of the American Cancer Society and by the fact that funds of this organization for which commitments had not been made, were available and by the fact that several other groups also were preparing independently to inaugurate such cancer detection centers. Among these other groups was the Elsa U. Pardee Foundation, a private foundation the interest of which is in cancer. In an effort to prevent chaos in such a program and to coordinate the interests and activities of the several groups concerned, the Academy of Medicine of Cleveland,[1] acting through its Committee on Cancer, secured the cooperation of the Cuyahoga Division of the American Cancer Society, the Pardee Foundation, and the Cleveland Hospital Council, which is a voluntary policy forming and purchasing organization of the Cleveland hospitals, to participate in a joint, large scale effort in the organization and operation of cancer detection centers in Cleveland hospitals.

The program is organized according to the scheme shown in Figure 1. It should be emphasized that such a plan of organization might serve as a model for the organization of a similar program in any community where organized medicine, one or more hospitals, and one or more health agencies,—whether they be public, private, or voluntary,—are involved. This is for the very important reason that organization along such lines permits the financial and administrative participation of any number

or kind of health agencies but invests in organized medicine sole authority for the determination of medical policy. In these several respects the Cleveland plan is possibly unique.

In reference to Figure 1, it is apparent that the practicing physicians comprise the membership of the county medical society which in turn functions through committees. The committee on cancer has two functions in the cancer detection center through the common appointment center where the applicant is interviewed by telephone in order to determine his or her eligibility for the clinic examination and where an appointment is made for examination at a specific center. The examination is performed by physicians selected by the staff of the hospital in which the center operates and the examination itself conforms to the standards adopted for the program after cooperative study by physician rep-

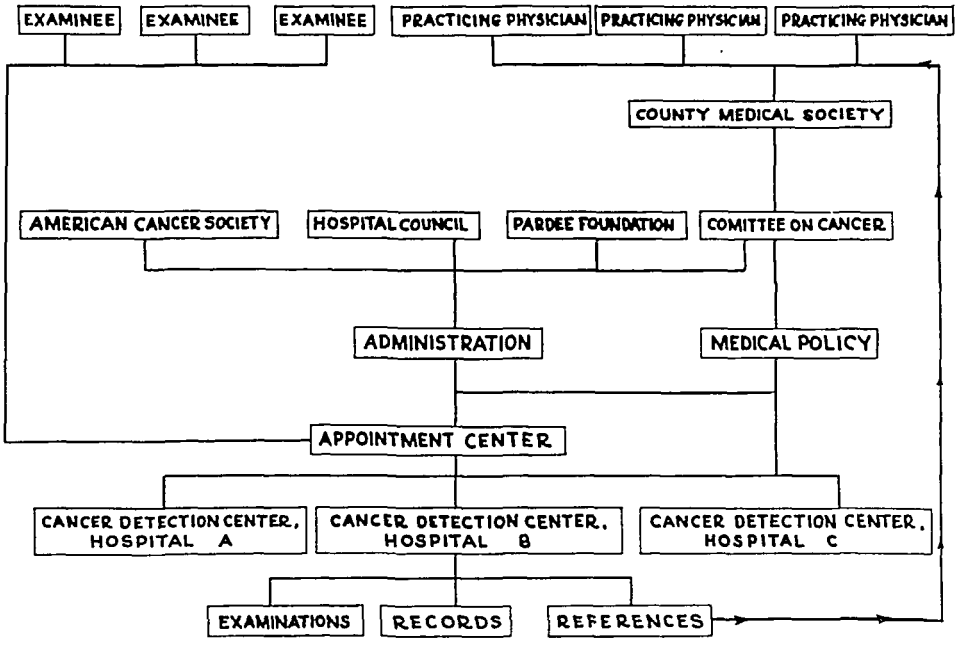


FIG. 1. Organization of cancer detection centers in Cleveland. (Courtesy of the Cleveland Health Museum.)

program. One is cooperative with the other participating agencies,—in this case the American Cancer Society, the Cleveland Hospital Council, and the Pardee Foundation. To this group might be added any number of other agencies, as, for example, visiting nurse associations, other private foundations, or federal, state, or local departments of health. The other function of the committee on cancer is exercised solely and exclusively by it and consists of the formulation and the supervision of medical policy in the appointment center and the coordination of medical policies in the cancer detection centers themselves. The applicant's, or examinee's, first contact with the cancer detection center is resentatives of the several centers meeting with the committee on cancer. These standards are subject to review, modification, deletion, and addition at intervals. The manner in which the prescribed examination is performed is left to the option of the individual clinics. Prescribed records are completed and become the property of the hospital in which the center is located. Examinees in whom abnormalities are found are referred to physicians of their choice with an abstract of the findings of the center. Examinees in whom no abnormalities are found are reassured and invited to make another appointment after six months.

When the program is examined in this fashion it is apparent that it is neither sepa-

rate nor distinct from the practice of medicine as it is known today but is both a part of it and an adjunct to it and that, in the final analysis, the program belongs to the practicing physicians for it is they who comprise the Academy of Medicine. The program is therefore subject to extension, alteration, and even termination by the wishes of these practicing physicians expressed through the Academy of Medicine.

Fifty per cent of the cost of the program is borne by the examinee. The other 50 per cent is borne approximately equally by the American Cancer Society and the Pardee Foundation.

The demands made upon the appointment center for appointments for examinations are in great part dependent upon the publicity given the program. Newspaper publicity of the type used in Cleveland results in such public response that the facilities of the appointment center are overtaxed for several weeks.

CLINIC	ELIGIBILITY		PHYSICIANS REIMBURSEMENT	EXAMINEES FEE	PHYSICAL EXAMINATION		LABORATORY			
	WELL ONLY	ALL	PER PERIOD		COMPLETE	LIMITED	BLOOD	URINE	CHEST X-RAY	VAGINAL SMEAR
1	X		$ 10.00	$ 5.00	X		X	X		X
2	X		0 & $ 5.00	$ 5.00	X		X	X	X	
3		X	VOLUNTEERS FROM COUNTY MEDICAL SOC.	-0-	X			X		X
4	X		-0-	$ 5.00	X					X
5	X		VARIABLE	$ 7.50	X		X	X	X	
6		X	-0-	VOLUNTARY	X					X
7	X		$ 12.50 (3 HR)	-0-		X*		X	X	X**
8	X		$ 10.00	$ 5.00	X		X	X	X	
9	X		-0-	$ 5.00	X		X	X	X	
10	X		VOLUNTEERS FROM COUNTY MEDICAL SOC.	$ 7.00	X		X			

* EXAMINATION LIMITED TO N. & T., SKIN, BREASTS, ABDOMEN, PELVIC, RECTAL

** ACTUAL INCISIONAL BIOPSY OF UTERINE CERVIX

Fig. 2. Summary of practices of ten representative cancer detection centers.
Clinic 1: Cancer Detection Clinics of Cleveland.
Clinic 2: Cancer Prevention Clinics of Chicago.
Clinic 3: Milwaukee Cancer Detection Center.
Clinic 4: Los Angeles Cancer Prevention Clinic.
Clinic 5: Strang Cancer Prevention Clinics, New York.
Clinic 6: Kent County Cancer Detection Clinics, Detroit.
Clinic 7: Cancer Detection Center, Johns Hopkins Hospital.
Clinic 8: Tulane University, School of Medicine, New Orleans.
Clinic 9: St. Elizabeth's Hospital, Youngstown, Ohio
Clinic 10: Cancer Detection Center, Grand Rapids.
(Courtesy of the Cleveland Health Museum.)

Figure 2 reviews the practices of ten representative cancer detection centers, Number 1 being the Cancer Detection Centers of Cleveland. Most admit only the apparently well. Physicians are either serving the centers on a voluntary basis or are being reimbursed at a rate of about $5.00 an hour. In most centers the examinee is carrying at least a substantial part of the cost of the

program. The examinations performed in the clinics are routine but tend to be exhaustive in their scope. The amount and character of the laboratory work performed is variable but the usefulness of the Papanicolaou[9] principle of diagnosis of carcinoma of the uterus is gaining wide acceptance.

The character of the prescribed examination justifies more consideration than has heretofore been given it. The tendency in all the centers has been to broaden the scope of the examination. This requires, of course, that more time must be devoted to it which means that fewer applicants can be examined by a given number of physicians or, vice versa, that more physician-hours are required to examine a given number of applicants. In the Cleveland program at the present time two physician-hours are required for the examination of three applicants.

This aspect of the cancer detection center program has certain very important implications. There are only two kinds of examinations which can be performed—and when the term examination is employed the taking of a medical history is implied—the one, the exhaustive, complete examination and the other, the screening examination with the arbitrary elimination of some features of the first type. At first thought, it would appear that the first kind is the only type justified but some consideration of the statistical aspects of the disease cancer and of the problem from the point of view of the preservation of the health of the whole people would suggest that some modification of the examination might properly be made. Study of the statistical incidence of cancer of the male and female (Fig. 3 and 4) shows that cancer of the digestive tract, uterus, breast, genitals (in the male), skin, and mouth comprise 75 to 80 per cent of all cancer. A simple screening examination consisting, then, of a few questions concerning the digestive tract and inspection, palpation, and digital examination of the skin, mouth, breasts, uterus, and the rectum would serve to exclude the great majority of cancers. To this might be added the vaginal smear but other routine laboratory work would not contribute greatly to such a screening procedure. If such a procedure were adopted it is likely that three or more times the number of applicants might be examined per physician-hour than is now possible with the elaborate procedures performed. This means, of course, that a far larger group of the population could have the benefit of such a survey.

Six centers are in operation in Cleveland and at the present rate of examination only a total of 3,600 applicants can be examined in one year.

There are in Cuyahoga County 650,000 persons over the age of thirty. The 3,600 applicants which it is possible for the clinic progran to examine at the present rate represent less than 0.6 per cent of the total population over the age of thirty. It costs, at the present rate, $10.30 to examine each applicant in the centers or a total of $37,000 for the year's total number of applicants. It can be predicted on the basis of the present method of screening applicants by telephone that 1 cancer will be found for every 200 applicants examined. The incidence of unsuspected cancer among examinees will vary, of course, depending upon the character of the telephone screening employed and if all applicants are admitted indiscriminately or if applicants are admitted through special agencies interested in cancer the incidence will be very much higher than this. This would anticipate a total of 18 cases of unsuspected cancer discovered this year among the 3,600 examinees of the clinics at a total cost of $37,000, or $2,000 for each case discovered.[2]

When these aspects of any cancer detection center program are studied, and while these statistical aspects may differ in detail from one center to another they will not differ greatly in general, one may logically raise the question whether such an extraordinary expense is justified considering the very limited portion of the population served. These aspects emphasize the need

for giving greater consideration to the type of examination performed in these centers with a view to increasing manifold the number of applicants who can be examined in each physician-hour. In any event the statistical importance so far as the preservation of the public health is concerned.

These considerations have resulted in the disapproval of the cancer detection center program by some county medical societies,

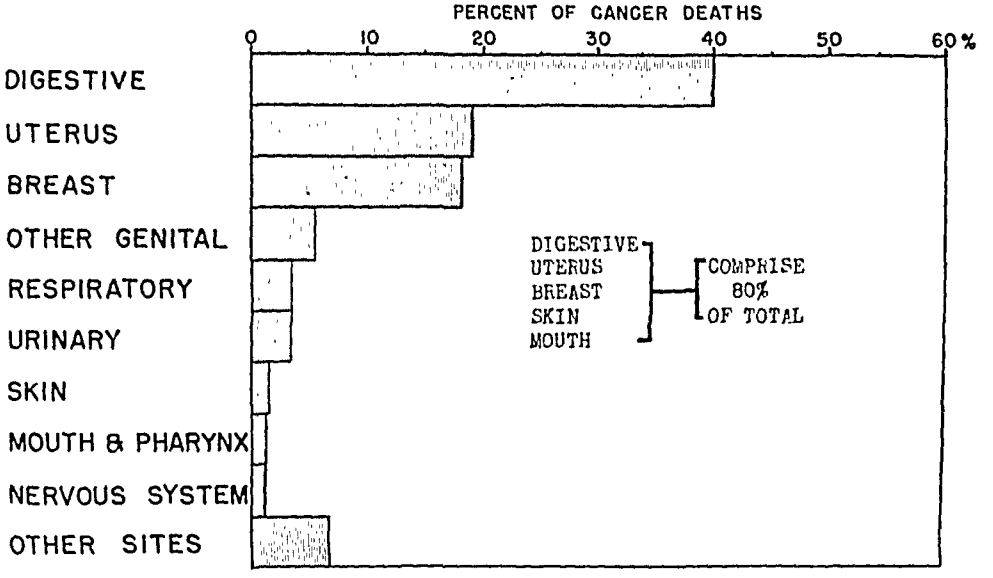


FIG. 3. Percentage of cancer deaths by sites for females. Bureau of Vital Statistics Reports, 1944. (From *Cancer News*, American Cancer Society.) (Courtesy of the Cleveland Health Museum.)

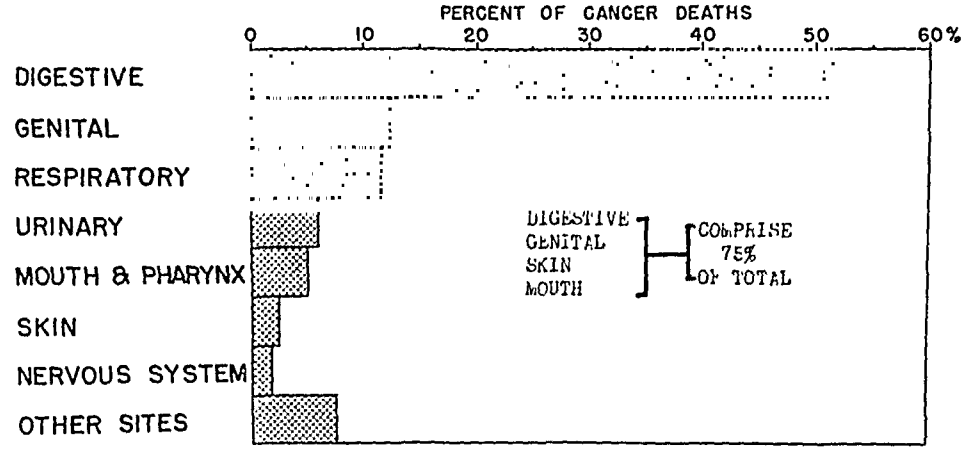


FIG. 4. Percentage of cancer deaths by sites for males. Bureau of Vital Statistics Reports, 1944. (From *Cancer News*, American Cancer Society.) (Courtesy of the Cleveland Health Museum.)

whole cancer detection center program must be viewed as a very luxurious service performed for a fortunate few and for this few the value of the service is inestimable. It is obvious, therefore, that the program as presently constituted and conducted, while of the utmost importance so far as the individual examinee is concerned, is of no the feeling being that the cost is excessive and that, in some instances, the purpose of early diagnosis is defeated by accumulating back-logs of applicants with a waiting list extending several months into the future.[5]

Where economic principles or implications are concerned the relationship between the applicant and the participating

agencies, whether they be public, voluntary, or private, whereby such agencies contribute to the cost of the service performed for the applicant, seems well validated. In the case of the public agency the applicant presumably has contributed to its support by taxation and should therefore be entitled to participate in its benefits; in the case of the voluntary agency the applicant presumably has contributed to its support by gift and is therefore entitled to share its benefits; and in the case of the private agency the express purpose of such an agency may be to give such aid.

This economic relationship beween physicians and the participating agencies is neither so clear nor so valid. The service which the examining physician performs is not experimental; it is an established and skillful procedure. It is a service for which, if it were performed in his own office, he would be well reimbursed. It is a service which no public agency would expect him to perform without adequate reimbursment and neither would he perform it under those circumstances for such an agency. And yet, through custom, the voluntary and private agencies have come to expect that the examining physician himself will participate financially in the program either by volunteering his services or by accepting for them a small honorarium. Reference again to Figure 2 shows that in about half the centers the physicians' services are rendered on a voluntary basis while in no case does the rate of reimbursement exceed $5.00 an hour. It is my opinion, whatever the source of funds,—whether from public, voluntary, or private agencies,—that reimbursement of the participating physician should in all cases be commensurate with the character of the services performed.

If the concept of the cancer detection center is to gain wide acceptance it must be demonstrated that there are certain advantages to such a cooperative program over periodic examinations performed by individual physicians. The one great justification for the program is the perhaps unfortunate fact that the private practitioner has neither the time nor the inclination to perform periodic examinations of the presumably well. The other advantages of the cooperative program over individual initiative have to do with the greater average skill, at least so far as the recognition of cancer is concerned, of the physicians participating in the program, and the greater degree of efficiency, with corresponding reduction of unit cost, which can be achieved by group effort.

Organized medicine is,today, under great stress from many agencies and groups. In the past, organized medicine has tried to remain aloof from such pressure. Organized medicine can no longer, however, categorically and continuously resist and condemn this pressure and the movements initiated by others. The health of the people is the concern of the people. The health of the people is neither solely nor exclusively the prerogative of the medical profession but is the problem of the people itself and therefore of the agencies through which the people act,—federal, state, local, voluntary and private and including the practice of medicine for the latter derives its privileges from, and is responsible to, the people. The concept of the cancer detection center has caught the fancy of the public, and of public, voluntary, and private health agencies to a greater degree than it has appealed to organized medicine itself. The concept, however, must be accepted by organized medicine. The cancer detection center program can be viewed as a clinical research effort—it is not only the laboratory research effort which should have the support of organized medicine—a clinical research effort in the possibilities of the early diagnosis of cancer. Like any other research effort in the field of cancer it may require ten or more years to come to fruit. In the end, it may be found that the chief usefulness of the cancer detection center program was the education of the public and the physician alike to the desirability of periodic examination.

In closing, one might properly quote the words of that distinguished teacher, brilliant scientist, and great humanist, James

Ewing,[6] whose comprehension of the cancer problem in all its aspects was so complete, " . . . there is no room for doubt that the establishment of cancer prevention clinics, while luxurious and somewhat difficult, is one of the best methods for detecting early cancer and precancerous changes. Any community that can establish such an organization would render a valuable service."

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CRITERIA FOR REPORTING END RESULTS*

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THE present day marks the convergence of all trends in cancer to a concentration on the subject, unprecedented in its history. Research in laboratories, in special cancer hospitals and clinics and in general hospitals is going on all over the world. Symposia, international conferences at which leaders in research, diagnosis, therapy and administration report progress, method, and result have demonstrated that although cancer is the problem of every small community, it is also international in its implications. There were more than fifty thousand separate monographs on cancer in the medical literature even before the discovery of Röntgen, and the number since that time has nearly matched the production of nineteen centuries. Yet there are simple facts as to volume, site, incidence and prevalence which are still conjectured rather than specifically known, because no specific criteria for reporting have been established. The different methods of treatment and the end results of the several contributors to this store of information may not be compared except in occasional instances for the same reason.

It has become the practice of many statisticians teaching research methods to students in the medical schools to demonstrate by analysis of papers in current medical journals the requirements of adequate, scientific and literate reporting. It so happens that for the past twelve years the reports of Berven, Martin, Richards and Ralston Paterson have been among patterns I have used as the goal to which the future physicians might well aspire.

The four general criteria for reporting end results are a clear definition of the limits of the anatomic site, a precise statement of the actual time interval involved, a statement of the total number of individuals diagnosed as having cancer of the anatomic site in question in the stated interval of time, whether or not all were treated, and a statement of the actual known status as to presence or absence of the disease of all individuals in the series so that cure and survival rates may be computed. These are self evident and occur to every clinician who studies his results. The many factors which influence end results are so interrelated that unless the disposition of every individual with cancer known to the physician is listed, selection is made at this point, and subsequent students are at a loss in attempting logical comparisons.

From 1936 through 1938 in an effort to obtain the average percentage of five year cures and the percentage of five year cures among the most favorable cases in twenty-eight selected sites, I made a survey of the literature of cancer. Thousands of articles published between 1930 and 1938 were read. Those containing end result figures were abstracted to the following form (Table 1).

No reports were included in which the time interval was uncertain, the number of cases too small, or the results based on less than a five year cure or survival. Four hundred and five separate monographs were abstracted. The range of reported cure rates made any combination of results of different authors hazardous, and the different types of total figure upon which percentages were based made the material difficult to interpret. The survey was useful primarily as a demonstration of the need for consistency in reporting end results, at least net results, regardless of the personal and desirable differences in methods of

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presenting the factors influencing these end results.

The high mortality among individuals with cancer has led to the introduction into the statistics of cures and survivals of cancer of a fallacy that is not common in statistics of many other disease entities. An individual treated for cancer and lost to follow up, even though he was clinically free of cancer for several years following treatment is frequently presumed dead of disease and is called a failure. Why it is considered a sound procedure to classify as dead of disease large numbers of individuals who did not continue to report for periodic checks, sometimes after the passage of three, four or more years without symptoms, when it would be considered unsound to call these individuals cured is one of the phenomena which is peculiar to cancer. It follows the theory that to weight results against oneself is to err on the side of accuracy. In the past eight years, in the process of constructing a registry of every individual known to have had cancer in Connecticut since January, 1935, an unusual opportunity to test this theory has come to me. After abstracting every hospital and clinic chart of every patient with cancer in a given institution, and searching for every name in the state Bureau of Vital Statistics from the last date on which that individual was known to be alive to the day of the check, I had a list of names for whom no certificate of death from any cause was filed. I returned to the hospital with this list and prepared letters to the physicians who had treated these patients to ask their cooperation in tracing them and determining their state of health. Connecticut is a small state of under two million inhabitants. Most of the patients lost to follow up were private patients. Fifteen hundred invididuals were found alive, who had been treated for cancer from 1935 through 1940 who, as of 1942, had never been checked clinically by any physician after their initial treatment for cancer. Hundreds of them were presumed dead by the specialists who had treated them. Some of these patients had cancer and eventually died with the disease. Some of them were cures. All of them were brought back under observation, many were treated and were cured of early recurrence of disease. Four individuals who had had colostomies for cancer of the rectum, subsequently had resections of the growths and have been without disease for more than five years. Even in controlled laboratory experiments there are some indeterminate results. Individuals who are lost to follow up without evidence of disease at last medical check are more accurately classified as indeterminate than as dead of disease. The recent world disaster will either cause a large increase in the use of this category, or it will create a literature of purported failures to treatment of individuals whose lives were destroyed before they had a chance to survive successful treatment for the approved period of time.

Following the survey of the literature ten

TABLE I

ABSTRACTS

Author: Title of Article Date Name of Journal Comment not more than two or three lines; e.g., if confused as to total number.	Cases	Five year cures, selected samples	Five year cures of total cases, not only of operable cases	Five year cures of operable or favorable cases

possible methods of presenting end results were tested. The method recommended by the records committee of the Memorial Hospital was adopted by me as a clear cut way of explaining every contingency that arises in this field. It also is possible by combination to approximate reported results of others. Although all physicians reporting from the Memorial Hospital do not use this form, those who do, subscribe, in so doing, to the minimum criteria for adequate reporting mentioned above. This method of reporting net cures does not prevent an individual reporter from giving details of the factors influencing his end results, but it does give in one table, a concise statement of the disposition of every individual with cancer of a given site known to the hospital, state registry or physician as the case may be. The individual reporter has the breadth of his paper in which to contrast the condition of the individuals he treated with the condition of those who came too late or whose treatment failed. By giving his total experience he is making it possible for others to measure their experience by his, and to know the extent of the problem with which each of them is faced and the comparative results of their therapeutic efforts.

The following table (Table II) from the Connecticut Cancer Record Registry giving the five year end results of the cases of all patients with cancer of the tongue both early and advanced admitted to twenty-nine general hospitals in Connecticut during the years 1935 to 1942, inclusive, will be used to illustrate this method of presenting end results.

There were 200 patients with cancer of the tongue. There were 4 individuals whom we classified as indeterminate as to end result seen in Connecticut in this eight year period. There were no applicants for follow up after treatment elsewhere, who had no evidence of cancer. In almost every series there are usually one or more who fall in this category. There were none with cancer of the tongue who sought consultation only, although this usually does occur because of the proximity of sections of the state to the cancer centers in Boston and New York. There were no patients who refused treatment either for cure or for relief of symptoms. There was 1 patient who died four years after treatment of an accident and who had no recurrence of cancer of the tongue. There

TABLE II

FORM FOR PRESENTING END RESULTS

Five-Year End Results

This series consists of the cases of all patients with cancer of the tongue both early and advanced, admitted to 29 general hospitals in Connecticut during the years 1935–1942*

Total number of patients admitted		200
Indeterminate Group		
Applied after treatment elsewhere, no evidence of cancer on admission or thereafter	0	
Consultation only, no treatment requested	0	
Patient refused proffered treatment or palliation	0	
Dead within five years of other causes, without recurrence of cancer	1	
Lost track of within five years without recurrence of cancer	3	
Total number of indeterminate results		4
Determinate Group		
Total number minus those of indeterminate group		196
Failures		
Dead as a result of cancer	144	
Dead of other causes, cancer present	12	
Living with recurrent cancer	3	
Dead of other causes, unknown whether cancer present	2	
Lost track of with cancer	2	
Lost track of, possibility of recurrent cancer unknown	0	
Total number of failures in treatment		163
Successful Results		
Free from cancer at five years or more		33
Net Five Year End Results		
Successful results divided by determinate group		33/196 = 16.8

* All cases reported as cured have been pathologically proved to have cancer. Lack of pathological proof does not exclude failures.

were 3 individuals who were checked clinically for three and four years but who no longer answered requests that they return for check up. They were not listed as dead of any cause in the state Bureau of Vital Statistics, and all efforts to locate them failed. Because the end result as to cancer was clearly not known in these patients, they were listed in the indeterminate group and were subtracted from the total number of patients when the net five year end results were figured.

Those listed as failures to treatment were the 140 who died directly as a result of cancer, the 12 who died of other chronic degenerative diseases with cancer present, the 3 living with recurrent cancer, the 2 for whom we have death records ascribing death to other causes of whom there is no certain knowledge that cancer was not present, and the 2 who had late cancer when they were lost to follow up. There is often a small number of individuals who drop from clinical observation immediately after initial treatment in whom the possibility of recurrent cancer is not known, and these individuals are listed as failures. Occasionally, after persistent tracing one is found free of disease and the rejoicing is so general that the search for the other untraced patients is carried on with renewed vigor.

Those individuals known without reasonable doubt to be free of disease fall in the classification of successful results. The net five year end results are obtained by dividing the successful results by the determinate group. In this series in Connecticut 16.8 per cent were free from disease at five years. Some of these 33 individuals have been free from disease for twelve years. This is the overall picture in the whole state. Buried in this average is the excellent work of some individual men. The series includes the work of all physicians who diagnosed or treated patients with cancer of the tongue in the hospitals in this state in the time interval stated. As rapidly as the checking and sorting can be accomplished each anatomic site will be reported from the registry in Connecticut according to this method. Differences of opinion may occur as to the desired location for listings under the group headed failures or the cases called indeterminate. If reporters break down their totals in this or even in a more detailed way, by combination one may compare his results with the others.

The greatest source of disagreement with this method lies in the size of the indeterminate group. It is now known from my own experience that it is possible to trace at least 95 per cent of all individuals treated for cancer even when one is faced with the necessity for backtracking fifteen thousand individuals from one to six years after their initial treatment. This was accomplished in Connecticut through effort and remarkable cooperation. Every physician in the state has been written to about at least one individual, and every medical record librarian has demonstrated ingenuity and generosity in searching out former patients. The individuals themselves have shown gratitude at the interest that has been taken in them. More than half the forty thousand individuals recorded in the Connecticut registry were private patients. At no time has the indeterminate group been as high as 10 per cent in any site reported from this registry and usually it is much less than that. At the recent International Cancer Conference in St. Louis, Missouri, several of the men who had exhibits and many of the individuals reading papers had selected this form for reporting their results. A literature is beginning to develop in which, for reports of results of treatment of cancer of a given anatomic site, statistical differences may be figured with assurance, and a cooperative search may be mde for underlying causes for differences discovered in the sincere and constant effort of every physician treating individuals with cancer to improve the prognosis for his patients.

Connecticut State Department of Health
Hartford, Conn.

DEPARTMENT OF TECHNIQUE

Department Editor: ROBERT B. TAFT, M.D., B.S., M.A., 103 Rutledge Ave. Charleston, S. C.

THE PREPARATION OF RADON VASELINE OINTMENT

By E. L. HARRINGTON*
University of Saskatchewan
SASKATOON, SASKATCHEWAN

WHETHER or not the radon technician is convinced of the therapeutic value of the radon ointment for use in the treatment of non-healing radiation ulcers he is likely to be called upon to prepare the same. Several rather elaborate methods which employ cylinder-piston combinations have been described, but none as simple nor affording as direct a control of strength as the one herein reported. It has been in use for some time at the radon plant of the Saskatchewan Cancer Commission, located at the University of Saskatchewan and operated by the Department of Physics.

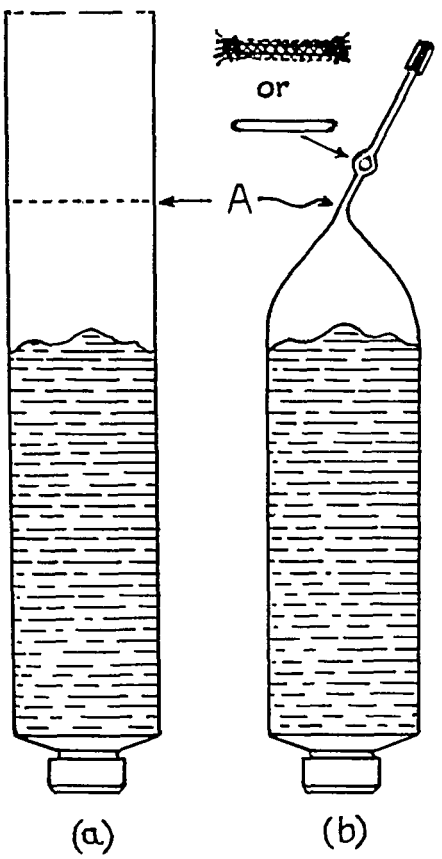


FIG. 1. Collapsible metal tube for containing radon ointment. (*a*) Partially filled, end still open. (*b*) Tube flattened and bent, radon glass capillary introduced, end clamped gas tight, in preparation for breaking glass.

The first step is to introduce the requisitioned quantity of the vaseline or vaseline-lanolin mixture into a standard collapsible metal tube somewhat larger than is required to hold the quantity to be activated. Such empty tubes may be obtained perhaps from a prescription druggist, but certainly from a wholesale drug company. One then prepares a slender glass capillary or "seed" containing the amount of radon needed to give the desired radioactivity to the quantity of ointment being prepared. It is of course rather difficult to get the exact amount desired but if the technician selects a capillary containing slightly more than is required he may reduce the amount by one or more of these methods: altering the length and contents of the capillary, the quantity of vaseline mixture, or the time allowed to elapse before applying the ointment to the patient. One might infer from the literature that the matter of exact strength is not a critical one nor one on which there is any general agreement.

Preparatory to the introduction of the radon one bends, *but without tightly crimping*, the tube just above the mixture as

* Professor of Physics, University of Saskatchewan, and consulting physicist to the Saskatchewan Cancer Commission.

shown by *A* in Figure 1. Above this the capillary tube is inserted and finally the top is closed, tightly crimped and folded to make sure that the end is gas tight. The glass tube is then broken easily since the flexible metal tubing offers little resistance to the slight bending required to break the tube. Care should be exercised to avoid crushing the tube. The bend at *A* should prevent the broken glass from getting into the ointment, but one might prefer to have the capillary tube enclosed in a muslin tube or in a short section of a hollow (braided) string before inserting the tube. In order to expedite the absorption of the radon in the mixture the prepared tube is then lowered into a beaker of water and the temperature raised until its contents are quite fluid. As an indicator of the proper temperature one may use either a thermometer or a test tube containing a small amount of the same mixture. The tube is then shaken sufficiently to ensure a uniform exposure to the radon.

The method described would seem to offer complete control at every stage without any danger of allowing any radon to escape. Also, it requires no special equipment nor difficult technique. The success of the procedure herein described was in part due to the skill and care exercised by the technician, Mr. R. W. Harrington.

University of Saskatchewan
Saskatoon, Sask.

THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

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Thirty-first Annual Meeting: Ambassador Hotel, Atlantic City, N. J., June 5–7, 1949.

EDITORIALS

THE FIFTIETH ANNIVERSARY OF THE DISCOVERY OF RADIUM

THE story of radium is at once a romance, filled with picturesque and adventurous scenes which stir the imagination; a drama of great events with the world for its stage, and not without tragedy; and an epic of heroic proportions, which begins in an humble laboratory, assumes a major role in the battle against cancer, reaches a climax in the atomic bomb, and continues into the future with possibilities that no man can foresee.

When the story is written it must begin in the year 1896 with Henri Becquerel, who, acting upon a mistaken hypothesis of Henri Poincare that fluorescence or phosphorescence was the origin of the recently discovered x-ray, was conducting some simple experiments with compounds containing uranium. In the course of these experiments he made the original discovery that uranium emitted rays which could penetrate metallic and other solid objects and which produced effects upon photographic plates like ordinary light. This discovery led directly to the research labors of Marie Sklodowska Curie and her husband Pierre Curie during the succeeding two years. Their patient investigation of uranium ores culminated in December, 1898, in the isolation of a radioactive substance which emitted two million times as much radiation as uranium. They named it "Radium." Their subsequent study of the new substance included both its physical properties and its biological effects. In 1901, Becquerel, who was associated with them in their work, was accidentally burned by a sample of radium which he was carrying in his vest pocket. Soon afterwards Pierre Curie suffered a severe radiation reaction by intentionally applying radium to the skin of his arm. After this the Curies carried out numerous animal experiments to show the biological effects of radioactivity, a term which had been originated by Marie Curie. They are therefore rightly regarded not only as the discoverers of radium but as the pioneers in radium therapy.

In the year 1905 Bergonié and Tribondeau announced their famous law which is the rational foundation of radiation therapy. From that day to the present time radium in some form has been an important weapon in the battle against cancer. The story of its use, sometimes alone, but more often in conjunction with surgery or the roentgen ray, or both, has been fully recorded in the medical literature of the world. On this fiftieth anniversary of its discovery the value of radium for the treatment of cancer and other diseases is well established and its limitations are well known.

We pause to pay tribute to the discoverers and pioneers, but in proportion as we have their faith and vision we will fix our eyes upon the possibilities of progress which are opening up before us in the field of radioactivity. Much has been accomplished already in exploration of the field of the artificially produced radioactive isotopes. It is true that the early optimism concerning their beneficial action in cancer has not been justified. P^{32} causes remissions in leukemia but probably no more effectively than established methods of roentgen treatment. It seems, however, to have proved itself as the treatment of choice of polycythemia vera. I^{131}, because of its concentration in the thyroid gland, seems ideal

for treatment of thyroid cancer but this, too, has been disappointing because the cancer itself exhibits no particular selectivity for the radioactive iodine.

In spite of these unencouraging results progress has been made in establishing the criteria that must be met in the further search for radioactive substances which may be effective in the treatment of cancer. For example, the useful isotope must have a half-life value neither too long nor too short. It must not be so long as to be a menace because of its long retention within the body; it must not be so short as to be relatively inert by the time it is possible to introduce it into the body. Again, only those isotopes which are selectively absorbed by some organ, tissue, or type of cells will be of value for treatment. Na^{24}, which is evenly distributed in the extracellular body fluids throughout the body, offers no possibility for use in the treatment of malignant disease, although it is a valuable tool in medical research.

Research workers throughout the world are eagerly investigating the application of the radioactive isotopes to cancer therapy. A particularly inviting field is the incorporation of radioactive elements into complex organic compounds, nucleoproteins for example. The number of possible compounds in this field would seem to be almost unlimited and the relationship of nucleoproteins to rapid cell division is suggestive of the possibility that a compound may be discovered which would be the vehicle to localize radioactive substances in cancerous tissues.

The dangers in the use of these new radioactive agents must be fully recognized. It is gratifying to know that they are not to be distributed until those in charge of their distribution are satisfied of the adequate training and experience of those who are to use them, and of the provision of proper facilities for their handling and application. Douglas Quick, in the Carman Lecture for 1947, has laid emphasis upon the shortcomings of the method, or lack of method, for the distribution of radium and radon in the United States. He recommends especially the complete integration of radium therapy with therapeutic radiology. The best results are obtained only when the possibilities of roentgen and radium therapy are fully considered and correlated in each individual case. The following brief quotations from his Lecture which is filled with important suggestions are timely in this anniversary year: "Radium fills a place in the field of radiation therapy that, so far, cannot be otherwise provided; unless it is used, and its applications taught, the man in training will never know of those advantages, and the unfortunate patient is apt to become a casualty by omission." . . . "The important feature is to have the radium a part of, and controlled by, the therapy department. It should not be loosely and miscellaneously spread about." . . . "The major responsibility of therapy by irradiation is still directed toward the relief of cancer. It is a serious responsibility. The least we can do is to provide and insist upon a full and complete training before endorsing assumption of such an obligation."

Notwithstanding the wider applicability of the roentgen ray than was the case before high voltages were available, radium continues to occupy an invaluable place in the treatment of cancer. It is vitally important, in every case in which its use is indicated, that it be applied by one who is fully informed of its hazards and who is adequately trained in all that pertains to dosage and methods of application. A fact that is little appreciated by the casual user of radium is that inadequate irradiation, whether because of under-dosage or poor distribution, is quite as harmful as overdosage, since it may result in failure to cure a curable cancer.

Pierre and Marie Curie in their little laboratory in a shed fifty years ago had no intimations of the revolutionary effects of their discovery upon physical science nor of its beneficent role in the treatment of cancer. We of the present generation can

best show our appreciation of their great contribution to humanity by perfecting and extending the use of the agent which they discovered and by pressing forward to new discoveries in the field in which they were the pioneers.

Arthur C. Christie, M.D.

THE ANNUAL MEETING OF THE AMERICAN RADIUM SOCIETY

THE fiftieth anniversary of the discovery of radium was celebrated at the recent meeting of the American Radium Society held in Chicago from June 20 to 22, 1948. "The Achievements of Radium in the Fight Against Cancer" was the topic of the Janeway Lecture by Sir Stanford Cade and an address on "Fifty Years of Radium" was delivered by Dr. Edith H. Quimby. The relative position of radium, roentgen rays and surgery in the treatment of cancer was discussed in symposia refresher courses and separate papers. The attendance at the meeting was one of the largest in the history of the Society and the presentations were well received. Important contributions to the program were made not only by representatives of radiotherapy from the United States and Canada but also by the following invited European guests of the Society: Baclesse, Baud and Lamarque of France; Berven of Sweden; Cade, Windeyer and Wood of England, and McWhirter of Scotland.

A symposium was held on "Should Radiotherapy be Separated from X-ray Diagnosis?" Those favoring this move brought forward much more convincing arguments than those opposing the change; they clearly showed the advantage of separation to the cancer patient and to the development of radiotherapy as a whole. The over-all improvement in radiotherapy following separation in some hospitals in the United States, in Sweden and especially in England made it seem inevitable that sooner or later this example will be followed throughout the United States, especially in the larger hospitals.

In the symposium on the "End Results of Treatment of Cancer of the Tongue" a five year follow-up was reported in over three thousand cases from seven outstanding American and European Clinics. Six of the seven speakers chose radium for the primary lesion in the tongue. The French and most British authors advised interstitially placed low intensity radium element needles; whereas Wood and Berven relied chiefly on external radium beam. In addition to the external irradiation, however, Berven electrocoagulated small uncontrolled cancer rests in 80 per cent of his cases. Only Hayes Martin of New York stated that he was reverting to excision, because of disappointment with irradiation of the primary lesion.

The problem of metastasis to cervical lymph nodes was dealt with at the Curie Foundation by routine radical neck dissection in all cases. Wood adjusted the fields of the radium beam for the primary tongue lesion in such a manner as also to include the lymph node bearing area. All other authors treated nodes only when clinically metastatic: When fixed, they were irradiated; when movable, Cade and Windeyer advised resection; Berven treated first by radium beam and resected only if the nodes failed to respond to the irradiation. On the whole, one gained the impression that the majority obtained their best results by interstitial use of radium needles for the primary and radical neck dissection for cervical node metastases.

In the symposium on the treatment of mammary cancer, five year follow-up results were reported in over ten thousand cases. The chief differences of opinion were as to whether simple or radical mastectomy was preferable and whether preoperative and postoperative roentgen therapy was valuable in cases with axillary lymph node involvement. McWhirter was the only one advising simple mastectomy and treatment of the axilla solely by roentgen irradiation: Postoperative roentgen therapy in 513 cases was preceded by radical and in 310 by simple mastectomy; survival was respectively 44.8 per cent and 56.1 per cent. The six other speakers and Adair who opened the general discussion preferred radical

mastectomy; only some of the authors combined this with preoperative or postoperative roentgen therapy or both. Their five year survival figures in cancer limited to the breast varied from 60 to 87 per cent in the different clinics, irrespective of whether or not radical mastectomy was combined with radiotherapy. In cases with axillary metastases, however, the addition of preoperative or postoperative irradiation did seem to make a difference in some of the series where it was used routinely. Thus Cade's figures rose from 29 per cent to 35 per cent when radium was added and Berven quoted 30 per cent when only postoperative roentgen therapy was used and 34 per cent when preoperative and postoperative treatment was given. Windeyer always used postoperative roentgen therapy in this stage of the disease; Taylor in selected cases and Haagensen only when there was microscopic evidence that the operation did not completely remove the cancer.

In evaluating preoperative and postoperative roentgen therapy it is well to bear in mind published information on the efficacy of certain tumor doses as shown by microscopic examination of irradiated tissue and clinical follow-up of cancers of the breast treated only by roentgen therapy. Thus, on microscopic examination of preoperatively irradiated mastectomy specimens, marked radiation damage but not complete destruction of the cancer was noted in 38 patients receiving a tumor dose of 4,500 roentgens in eight weeks. The roentgen therapy was given a few days to one year before radical mastectomy at the Presbyterian Hospital, New York. Clinically, 10 of 32 of the patients with cancer limited to the breast and axilla and treated only by roentgen therapy, remained free from cancer for from seven to eleven years. This result was not obtained, however, until the tumor dosage was raised to 6,000 or 8,000 r in three months. Baclesse's experience at the Curie Institute, Paris, reported at this meeting, was similar. He also did not obtain clinical cures until his tumor dosage in three to four months was 8,000 r or more. McWhirter administered a tumor dose of 3,700 r in two to three weeks. The shorter period of treatment made this dosage more cancerocidal and some growth restraint undoubtedly followed, probably increasing the five year survival rate. It is not likely, however, that this dosage could completely destroy mammary cancer in lymph nodes, nor that it could be as effective as 8,000 r or over given in three to four months. It is difficult to compare McWhirter's statistics with those of the other speakers as the latter separated their operable cases into cases with and without axillary nodes, which McWhirter did not do. We will follow his experiment with interest, but for the present will advise radical mastectomy in cancer limited to the breast and even in those with a single involved node. Haagensen of the Presbyterian Hospital, New York, claims his radical mastectomies have done nearly equally well in both groups. We believe with Haagensen and with Taylor of the Massachusetts General Hospital that improvement in the results of radical mastectomy is more likely to come from stricter selection of cases for this operation than by the routine addition of preoperative or postoperative roentgen therapy. Too many inoperable cases are still operated upon, in the hope that radiotherapy will correct surgical mistakes. It would seem preferable not to operate on these cases but to refer them, after biopsy, solely for treatment with roentgen rays. More vigorous irradiation can then be given and greater growth restraint obtained.

The Refresher Courses, which were an innovation at this meeting and all separate papers were very well received. Refresher Courses will probably form part of future programs. There were discussed the treatment of cancer of the mouth, palate, larynx and pharynx, maxillary antrum, Bartholin gland, cervix, penis, rectum, and melanoma. A preliminary report was given on the use of cobalt^{60} in needles and there were described experimental studies on

comparison of gamma and roentgen rays. Refresher Courses are usually not published. A great many requests were received, however, to have the material mimeographed and sold at cost. This will be done.

This report would be incomplete if we did not mention the help extended by generous friends of the American Radium Society, making it possible to invite the European guests. The intense interest shown by the large audience testified to the appreciation of the presentations.

MAURICE LENZ, M.D.

SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

Items for this section solicited promptly after the events to which they refer

MEETINGS OF ROENTGEN SOCIETIES*

UNITED STATES OF AMERICA

AMERICAN ROENTGEN RAY SOCIETY
Secretary, Dr. H. Dabney Kerr, University Hospital, Iowa City, Iowa. Annual meeting: Netherland Plaza Hotel, Cincinnati, Ohio, Oct. 4–7, 1949.

AMERICAN RADIUM SOCIETY
Secretary, Dr. H. F. Hare, 605 Commonwealth Ave., Boston, Mass. Annual meeting: Ambassador Hotel, Atlantic City, N. J., June 5–7, 1949.

RADIOLOGICAL SOCIETY OF NORTH AMERICA
Secretary, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N. Y. Annual meeting: Hotels Fairmont and Mark Hopkins, San Francisco, Calif., Dec. 5–10, 1948.

AMERICAN COLLEGE OF RADIOLOGY
Executive Secretary, William C. Stronach, 20 N. Wacker Drive, Chicago 6. Annual meeting: Chalfonte-Haddon Hall, Atlantic City, N. J., June 5, 1949.

SECTION ON RADIOLOGY, AMERICAN MEDICAL ASSOCIATION
Secretary, Dr. U. V. Portmann, Cleveland Clinic, Cleveland, Ohio, Annual Meeting: 1949, to be announced.

ALABAMA RADIOLOGICAL SOCIETY
Secretary, Dr. W. W. Anderson, Tuscaloosa, Ala. Next meeting time and place of Alabama State Medical Association,

ARKANSAS RADIOLOGICAL SOCIETY
Secretary, Dr. Fred Hames, 511 National Bldg., Pine Bluff, Ark. Meets every three months and also at time and place of State Medical Association.

BROOKLYN ROENTGEN RAY SOCIETY
Secretary, Dr. A. H. Levy, 1354 Carroll St., Brooklyn 13, N. Y. Meets monthly on fourth Tuesday, October to April.

BUFFALO RADIOLOGICAL SOCIETY
Secretary, Dr. Mario C. Gian, 610 Niagara St., Buffalo, N. Y. Meets second Monday evening each month, October to May inclusive.

CENTRAL NEW YORK ROENTGEN RAY SOCIETY
Secretary, Dr. Dwight V. Needham, 608 E. Genesee St., Syracuse N. Y. Meets January, May, November.

CENTRAL OHIO RADIOLOGICAL SOCIETY
Secretary, Dr. Paul D. Meyer, Grant Hospital, Columbus, Ohio. Meets at 6:30 P.M. on second Thursday of October, December, February, April, and June at Seneca Hotel, Columbus, Ohio.

CHICAGO ROENTGEN SOCIETY
Secretary, Dr. John H. Gilmore, 720 N. Michigan Ave., Chicago 11, Ill. Meets second Thursday of each month October to April inclusive at the Palmer House.

CINCINNATI RADIOLOGICAL SOCIETY
Secretary, Dr. Eugene L. Saenger, 735 Doctors Bldg., Cincinnati 2, Ohio. Meets last Monday of each month, September to May, inclusive.

CLEVELAND RADIOLOGICAL SOCIETY
Secretary, Dr. George L. Sackett, 10515 Carnegie Ave. Cleveland 6, Ohio. Meetings at 6:30 P.M. on fourth Monday of each month from October to April.

COLORADO RADIOLOGICAL SOCIETY
Secretary, Dr. Mark S. Donovan, 306 Majestic Bldg., Denver 2, Colo. Meets third Friday of each month at Department of Radiology, Colorado School of Medicine.

CONNECTICUT VALLEY RADIOLOGIC SOCIETY
Secretary, Dr. E. W. Godfrey, 1676 Boulevard, West Hartford, Conn. Meets second Friday of October and April.

DALLAS-FORT WORTH ROENTGEN STUDY CLUB
Secretary, Dr. X. R. Hyde, Medical Arts Bldg., Fort Worth, Texas. Meets in Dallas on odd months and in Fort Worth on even months, on third Monday, 7:30 P.M.

DETROIT ROENTGEN RAY AND RADIUM SOCIETY
Secretary, Dr. E. R. Witwer, Harper Hospital. Meets monthly on first Thursday from October to May, at Wayne County Medical Society Building.

EAST BAY ROENTGEN SOCIETY
Secretary, Dr. Dan Tucker, 434-30th St., Oakland 9, Calif. Meets first Thursday each month at Peralta Hospital, Oakland.

FLORIDA RADIOLOGICAL SOCIETY
Secretary, Dr. F. K. Hurt, Riverside Hospital, Jacksonville, Fla. Meets twice annually, in the spring with the annual State Society meeting, and in the fall.

GEORGIA RADIOLOGICAL SOCIETY
Secretary, Dr. Robert Drane, DeRenne Apartments, Savannah, Ga. Meets in mid-winter and at annual meeting of Medical Association of Georgia in the spring.

HOUSTON X-RAY CLUB
Secretary, Dr. Curtis H. Burge, 3020 San Jacinto St., Houston 4, Texas. Meets fourth Monday each month.

RADIOLOGICAL SOCIETY OF KANSAS CITY
Secretary, Dr. Arthur B. Smith, 800 Argyle Bldg., Kansas City, Mo. Meets third Thursday of each month.

ILLINOIS RADIOLOGICAL SOCIETY
Secretary, Dr. Wm. DeHollander, St. John's Hospital, Springfield, Ill. Meets three times a year.

INDIANA ROENTGEN SOCIETY
Secretary, Dr. William M. Loehr, 712 Hume-Mansur Bldg., Indianapolis 4. Meets second Sunday in May.

IOWA X-RAY CLUB
Secretary, Dr. Arthur W. Erskine, 326 Higley Bldg., Cedar Rapids, Iowa. Luncheon and business meeting during annual session of Iowa State Medical Society. Special meetings by announcement.

KANSAS RADIOLOGICAL SOCIETY
Secretary, Dr. Anthony F. Rossitto, Wichita Hospital, Wichita, Kan. Meets annually with State Medical Society.

KENTUCKY RADIOLOGICAL SOCIETY
Secretary, Dr. W. C. Martin, 321 W. Broadway, Louisville. Meets annually in Louisville on first Saturday in Apr.

LONG ISLAND RADIOLOGICAL SOCIETY
Secretary, Dr. Marcus Wiener, 1430-48th St., Brooklyn, N. Y. Meets Kings County Med. Soc. Bldg. monthly on fourth Thursday, October to May, 8:45 P.M.

LOS ANGELES RADIOLOGICAL SOCIETY
Secretary, Dr. Moris Horwitz, 441 No. Camden Drive, Beverly Hills, Calif. Meets second Wednesday each month at Los Angeles County Medical Assn. Building.

LOUISIANA RADIOLOGICAL SOCIETY
Secretary, Dr. J. R. Anderson, 1130 Louisiana Ave., Shreveport. Meets annually during Louisiana State Medical Society Meeting.

LOUISVILLE RADIOLOGICAL SOCIETY
Secretary, Dr. E. L. Pirkey, Louisville General Hospital, Louisville 2, Ky. Meets monthly on second Friday at Louisville General Hospital.

* Secretaries of societies not here listed are requested to send the necessary information to the Editor.

MICHIGAN ASSOCIATION OF ROENTGENOLOGISTS
Secretary, Dr. R. D. McDuff, 220 Genesee Bank Bldg., Flint 3, Mich.

MILWAUKEE ROENTGEN RAY SOCIETY
Secretary, Dr. C. A. H. Fortier, 231 W. Wisconsin Ave., Milwaukee, Wis. Meets monthly on second Monday at University Club.

MINNESOTA RADIOLOGICAL SOCIETY
Secretary, Dr. Chauncey N. Borman, 802 Medical Arts Bldg., Minneapolis 2, Minn. Two meetings yearly, one at time of Minnesota State Medical Association the other in the fall.

NEBRASKA RADIOLOGICAL SOCIETY
Secretary, Dr. Ralph C. Moore, Nebraska Methodist Hospital, Omaha 3, Nebr. Meets third Wednesday of each month, at 6 P.M. at either Omaha or Lincoln.

NEW ENGLAND ROENTGEN RAY SOCIETY
Secretary, Dr. George Levene, Massachusetts Memorial Hospitals, Boston, Mass. Meets monthly on third Friday, Boston Medical Library.

NEW HAMPSHIRE ROENTGEN RAY SOCIETY
Secretary, Dr. A. C. Johnston, Elliott Community Hospital, Keene, N. H. Meets four to six times yearly.

NEW YORK ROENTGEN SOCIETY
Secretary, Dr. Ramsay Spillman, 115 East 61st St., New York City. Meets monthly on third Monday, New York Academy of Medicine, at 8:30 P.M.

NORTH CAROLINA RADIOLOGICAL SOCIETY
Secretary, Dr. J. E. Hemphill, 323 Professional Bldg., Charlotte 2, N. C. Meets in May and October.

NORTH DAKOTA RADIOLOGICAL SOCIETY
Secretary, Dr. C. O. Heilman, 807 Broadway, Fargo. Meetings held by announcement.

NORTHERN CALIFORNIA RADIOLOGICAL CLUB
Secretary, Dr. C. E. Grayson, Medico-Dental Bldg., Sacramento 14, Calif. Meets at dinner last Monday, every second month, except June, July and August. Next meeting Sept. 27, 1948.

OHIO STATE RADIOLOGICAL SOCIETY
Secretary, Dr. Carroll C. Dundon, 2065 Adelbert Road, Cleveland 6, Ohio.

OKLAHOMA STATE RADIOLOGICAL SOCIETY
Secretary, Dr. W. E. Brown, Tulsa, Okla. Three regular meetings annually.

OREGON RADIOLOGICAL SOCIETY
Secretary, Dr. Boyd Isenhart, 214 Medical Dental Bldg., Portland 5, Oregon. Meets monthly 2nd Wednesday, 8:00 P.M., Library of University of Oregon Medical School.

ORLEANS PARISH RADIOLOGICAL SOCIETY
Secretary, Dr. Joseph V. Schlosser, Charity Hospital, New Orleans 13, La. Meets first Tuesday of each month.

PACIFIC NORTHWEST RADIOLOGICAL SOCIETY
Secretary, Dr. S. J. Hawley, 1320 Madison St., Seattle 4, Wash. Meets annually in May.

PACIFIC ROENTGEN SOCIETY
Secretary, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association.

PENNSYLVANIA RADIOLOGICAL SOCIETY
Secretary, Dr. J. M. Converse, 416 Pine St., Williamsport.

PHILADELPHIA ROENTGEN RAY SOCIETY
Secretary, Dr. Arthur Finkelstein, Graduate Hospital, 19th and Lombard St. Meets first Thursday each month October to May, at 8:00 P.M., in Thomson Hall, College of Physicians.

PITTSBURGH ROENTGEN SOCIETY
Secretary, Dr. R. P. Meader, 4002 Jenkins Arcade Pittsburgh 22, Pa. Meets 6:30 P.M. at Webster Hall Hotel on second Wednesday each month, October to May inclusive.

QUEENS ROENTGEN RAY SOCIETY
Secretary, Dr. J. E. Goldstein, 88-29 163rd St., Jamaica 3, N. Y. Meets fourth Monday of each month except during the summer.

RADIOLOGICAL SECTION, BALTIMORE MEDICAL SOCIETY
Secretary, Dr. Harry A. Miller, 2452 Eutaw Place, Baltimore. Meets third Tuesday each month, September to May.

RADIOLOGICAL SECTION, CONNECTICUT MEDICAL SOCIETY
Secretary, Dr. Robert M. Lowman, Grace-New Haven Community Hospital, New Haven 11. Meets bimonthly second Thursday, at place selected by Secretary.

RADIOLOGICAL SECTION, DISTRICT OF COLUMBIA MEDICAL SOCIETY
Secretary, Dr. A. A. J. Den, 1801 K St., N. W., Washington, D. C. Meets Medical Society Auditorium, third Thursday, January, March, May, October at 8:00 P.M.

RADIOLOGICAL SECTION, SOUTHERN MEDICAL ASSOCIATION
Secretary, Dr. Roy G. Giles, Temple, Texas.

RADIOLOGICAL SOCIETY OF NEW JERSEY
Secretary, Dr. Raphael Pomeranz, 31 Lincoln Park, Newark, N. J. Meets annually at time and place of State Medical Society. Mid-year meetings at place chosen by president.

ROCHESTER ROENTGEN RAY SOCIETY, ROCHESTER, N. Y.
Secretary, Dr. Murray P. George, Strong Memorial Hospital. Meets monthly on third Monday from October to May, inclusive, 8 P.M. at Strong Memorial Hospital.

ROCKY MOUNTAIN RADIOLOGICAL SOCIETY
Secretary, Dr. Maurice D. Frazer, 1037 Stuart Bldg., Lincoln, Nebr.

ST. LOUIS SOCIETY OF RADIOLOGISTS
Secretary, Dr. Edwin C. Ernst, Beaumont Medical Building, St. Louis, Mo. Meets fourth Wednesday of each month, except June, July, August, and September.

SAN DIEGO ROENTGEN SOCIETY
Secretary, Dr. R. F. Niehaus, 1831 Fourth Ave., San Diego, Calif. Meets monthly, first Wednesday at dinner.

SECTION ON RADIOLOGY, CALIFORNIA MEDICAL ASSOCIATION
Secretary, Dr. D. R. MacColl, 2007 Wilshire Blvd., Los Angeles 5, Calif.

SECTION ON RADIOLOGY, ILLINOIS STATE MEDICAL SOCIETY
Secretary, Dr. Harold L. Shinall, St. Joseph's Hospital, Bloomington, Ill.

SHREVEPORT RADIOLOGICAL CLUB
Secretary, Dr. R. W. Cooper, Charity Hospital, Shreveport, La. Meets monthly on third Wednesday, at 7:30 P.M., September to May inclusive.

SOUTH CAROLINA X-RAY SOCIETY
Secretary, Dr. T. A. Pitts, Baptist Hospital, Columbia, S. C. Meets in Charleston on first Thursday in November, also at the time and place of South Carolina State Medical Association.

TENNESSEE RADIOLOGICAL SOCIETY
Secretary, Dr. J. M. Frère, 707 Walnut St., Chattanooga, Tenn. Meets annually at the time and place of the Tennessee State Medical Association.

TEXAS RADIOLOGICAL SOCIETY
Secretary, Dr. R. P. O'Bannon, 650 Fifth Ave., Fort Worth 4, Texas. Next meeting Jan. 7–8, 1949, Fort Worth, Texas.

UNIVERSITY OF MICHIGAN DEPARTMENT OF ROENTGENOLOGY STAFF MEETING
Meets each Monday evening from September to June, at 7 P.M. at University Hospital.

UNIVERSITY OF WISCONSIN RADIOLOGICAL CONFERENCE
Secretary, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis. Meets first and third Thursdays 4:00 to 5:00 P.M., September to May inclusive. Room 203, Service Memorial Institute, 426 N. Charter St., Madison.

Utah State Radiological Society
Secretary, Dr. Angus K. Wilson, 343 S. Main St., Salt Lake City 1, Utah. Meets third Wednesday in September, November, January, March and May.

Virginia Radiological Society
Secretary, Dr. P. B. Parsons, Norfolk General Hospital, Norfolk, Va. Meets annually in October.

Washington State Radiological Society
Secretary, Dr. Homer V. Hartzell, 310 Stimson Bldg., Seattle 1, Wash. Meets fourth Monday each month, October through May, College Club, Seattle.

X-Ray Study Club of San Francisco
Secretary, Dr. Ivan J. Miller, 49 Fourth St., San Francisco 3. Meets monthly on third Thursday at 7:45 P.M., January to June at Lane Hall, Stanford University Hospital, and July to December at Langley Porter Clinic, University of California Hospital.

Cuba

Sociedad de Radiología y Fisioterapia de Cuba
President, Dr. J. Manuel Viamonte, Hospital Mercedes, Habana, Cuba. Meets monthly in Habana.

Mexico

Sociedad Mexicana de Radiologia y Fisioterapia
General Secretary, Dr. D. P. Cossio, Marsella No. 11, Mexico, D. F. Meets first Monday of each month.

British Empire

British Institute of Radiology Incorporated with the Roentgen Society
Medical Members' meeting held monthly on third Friday at 2:30 P.M. and Ordinary Meeting at same time on following Saturday, October to May, 32 Welbeck St., London, W.1.

Faculty of Radiologists
Honorary Secretary, Dr. J. F. Bromley, 45, Lincoln's Inn Fields, London, W.C.2, England.

Section of Radiology of the Royal Society of Medicine (Confined to Medical Members)
Meets third Friday each month at 4:45 P.M. at the Royal Society of Medicine, 1 Wimpole St., London.

Canadian Association of Radiologists
Honorary Secretary, Dr. E. M. Crawford, 2100 Marlowe Ave., Montreal 28, Que. Meetings January and June.

Section of Radiology, Canadian Medical Association
Secretary, Dr. C. M. Jones, Inglis St., Ext. Halifax, N. S.

Société Canadienne-Francaise d'Electrologie et de Radiologie Médicales
Secretary, Dr. Origéne Dufresne, 4120 Ontario St., East, Montreal, P. Q.

Australian and New Zealand Association of Radiologists
Honorary Secretary, Dr. Alan R. Colwell, 135 Macquarie St., Sydney, N.S.W.
Honorary Secretaries, State Branches:
New South Wales, Dr. E. W. Frecker, 135 Macquarie St., Sydney.
Victoria, Dr. T. L. Tyrer, 3 Lockerbie Court, East St. Kilda.
Queensland, Dr. J. Adam, 131 Wickham Terrace, Brisbane.
South Australia, Dr. B. C. Smeaton, 178 North Terrace, Adelaide.
Western Australia, Dr. A. M. Nelson, 179-B St. Georges Terrace, Perth.
New Zealand, Dr. E. G. Lynch, 12 Bolton St., Wellington.

South America

Sociedad Argentina de Radiologia
Secretary, Dr. Guido Gotta, Buenos Aires, Argentina. Meetings are held monthly.

Sociedade Brasileira de Radiologia Medica
Secretary, Dr. Nicola Caminha, Av. Mem de Sa, Rio de Janeiro, Brazil. Meets monthly, except during January, February and March.

Sociedade Brasileira de Radioterapia
Secretary, Dr. Andrelino Amaral, Av. Brigadeiro Luiz Antonio, 644, São Paulo, Brazil. Meets monthly on second Tuesday at 9 P.M. in São Paulo at Av. Brigadeiro Luiz Antonio, 644.

Sociedad Peruana de Radiologia
Secretary, Dr. Julio Bedoya Paredes, Apartado, 2306, Lima, Peru. Meets monthly except during January, February and March, at Asociación Médica Peruana "Daniel A Carrión," Villalta, 218, Lima.

Sociedad de Radiologica, Cancerologia y Fisica Medica del Uruguay
Secretary, Dr. Arias Bellini.

Continental Europe

Société Belge de Radiologie
General Secretary, Dr. S. Masy, 111 Avenue des Alliés, Louvain, Belgium. Meets monthly, second Sunday at Maison des Médecins, Brussels.

Ceskoslovenská společnost pro röntgenologii a radiologii v Praze
Secretary, Dr. Roman Bláha, Praha XII, stát. nemocnice, Czechoslovakia. Meets monthly except during July, August, and September. Annual general meeting.

Polish Society of Radiology
Secretary, Dr. L. Zgliczynski, 59 Nowogrodzka St., Warsaw, Poland. Next meeting, Krakow, June 2 and 3, 1949.

Gdansk Section, Polish Society of Radiology
Secretary, Dr. A. Smigielska, Akademia Lekarska, Gdansk. Meets monthly last Sunday at 10.30, X-Ray Dept., Akademia Gdansk.

Warsaw Section, Polish Society of Radiology
Secretary, Dr. L. Zgliczynski, 59 Nowogrodzka St., Warsaw, Poland. Meets monthly.

Societatea Romana de Radiologie si Electrologie
Secretary, Dr. Oscar Meller, Str. Banual Mărăcine, 30, S. I., Bucuresti, Roumania. Meets second Monday in every month with the exception of July and August.

All-Russian Roentgen Ray Association, Leningrad.
USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.
Secretaries, Drs. S. A. Reinberg and S. G. Simonson. Meets annually.

Leningrad Roentgen Ray Society
Secretaries, Drs. S. G. Simonson and G. A. Gusterin. Meets monthly, first Monday at 8 o'clock, State Institute of Roentgenology and Radiology, Leningrad.

Moscow Roentgen Ray Society
Secretaries, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky. Meets monthly, first Monday, 8 P.M.

Scandinavian Roentgen Societies
The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association.

Sociedad Espanola de Radiologia y Electrologia
Secretary, Dr. J. Martin-Crespo, Fuencarral, 7. Madrid, Spain. Meets monthly in Madrid.

Schweizerische Röntgen-Gesellschaft (Société Suisse de Radiologie)
President, Dr. H. E. Walther, Gloriastr. 14, Zürich, Switzerland.

Societa Italiana di Radiologia Medica
Secretary, Prof. Mario Ponzio, Ospedale Mauriziano Torino, Italy. Meets biannually.

LOS ANGELES RADIOLOGICAL SOCIETY

The first annual Mid-Winter Radiological Conference sponsored by the Los Angeles Radiological Society will be held at the Biltmore Hotel, Los Angeles, California on Saturday and Sunday, February 26 and 27, 1949. All of the courses will be given by prominent Pacific Coast radiologists. At the Biltmore Hotel on Saturday evening, February 26, a banquet will be held preceded by cocktails. The main speaker of the evening following the banquet will be Dr. Frederick E. Templeton of Seattle, Washington, whose subject will be "The Differential Diagnosis of Benign and Malignant Gastric Lesions." Reservations and information concerning the meeting can be obtained by writing to Dr. Donald Laing, 75 North Madison Avenue, Pasadena 1, California. Fifteen dollars is the fee for the entire two day session.

NORTH CAROLINA RADIOLOGICAL SOCIETY

The North Carolina Radiological Society held its October meeting in conjunction with the Matheson Foundation Medical Lectures in Charlotte, North Carolina, on October 22, 1948. During the morning session an hour was devoted to a Film Reading Session in which the following guests participated: Dr. Paul C. Swenson, Dr. Robert J. Reeves, Dr. J. P. Rousseau and Dr. E. P. Pendergrass. A paper entitled "Problems in the Diagnosis of Diseases of the Large Intestine" was given by Dr. Paul C. Swenson, Professor of Radiology, Jefferson Medical School, Philadelphia.

ANNUAL LIPIODOL AWARDS FOR 1948

Roentgenologists from all sections of the country submitted examples of diagnostic roentgenograms in the Annual Lipiodol Awards program for 1948. The technical excellence of the many entries offers further evidence of the great progress achieved in this specialty.

Awards were made to roentgenologists in four categories of roentgenography. Entries submitted were judged for the extent of diagnostic features revealed and general technical excellence of roentgenograms in otolaryngology, bronchography, uterosalpingography and the delineation of sinus tracts. The six roentgenologists receiving awards were: otolaryngology—Dr. Henry M. Scheer, New York; bronchography—Dr. J. A. Crellin, Philadelphia, and Dr. Louis Schneider, New York; uterosalpingography—Dr. A. P. Echternacht, Crawfordsville, Indiana, and Dr. B. S. Epstein, New York; sinus tracts—Dr. Sidney E. Foster, San Francisco, and Dr. B. S. Epstein, New York.

Entries were reviewed by a distinguished board of judges consisting of Dr. Lawrence Reynolds, President of the American Roentgen Ray Society; Dr. Ira H. Lockwood of Kansas City, Missouri, and Dr. Irving Schwartz of New York.

EXECUTIVE COUNCIL AWARDS AMERICAN ROENTGEN RAY SOCIETY

The Awards (First Award, $500.00; Second Award, $300.00) are granted for original, unpublished, scientific contributions prepared by candidates for admission to membership in the American Roentgen Ray Society and considered worthy of the Awards by the Executive Council. It is understood (a) that one, both, or neither of the Awards need be granted in a given year; (b) that the candidate receiving the Award must be elected to membership in the Society; and (c) that a suitable certificate accompany the Award.

ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

Department Editor: George M. Wyatt, M.D., 1835 Eye St., N.W., Washington 6, D. C.

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ROENTGEN DIAGNOSIS

HEAD

CAPPON, D. Intracerebral calcification in a microcephalic. *Lancet*, May 22, 1948, *1*, 795.

This is an incomplete case study of a nine months old female microcephalic Eurasian. Clinically the child was listless and backward. The chief interest centers around the roentgenogram of the skull which is well reproduced and presents a very unusual symmetrical calcification thought to be in the walls of grossly dilated lateral ventricles. Infantile toxoplasmosis is suggested as a possible diagnosis.—*J. S. Summers, M.D.*

PENNYBACKER, JOE. Cerebellar abscess; treatment by excision with the aid of antibiotics. *J. Neurol., Neurosurg. & Psychiat.*, Feb., 1948, *11*, 1–12.

In a series of 100 brain abscesses in the past nine years, 18 were cerebellar and, with one exception, all were due to mastoid infection. Of the first 9 cases, only 2 survived. Of the last 9 cases, 8 recovered.

Increased recovery of the latter group was directly referable to instillation of penicillin into the abscess cavity.

The author states that roentgenograms of the skull were of no particular help in diagnosis of cerebellar abscess other than to show the presence of a mastoid infection. On the other hand, instillation of thorotrast and penicillin into these abscess cavities following aspiration was of considerable help in judging the size of the abscess and therefore progress in healing. For example, if an abscess does not demonstrably reduce itself over a reasonable period of time as demonstrated by thorotrast, total excision is to be contemplated.—*Russell R. Jauernig, M.D.*

PHILLIPS, GILBERT. Primary cerebral hydatid cysts. *J. Neurol., Neurosurg. & Psychiat.*, Feb., 1948, *11*, 44–52.

Preoperative diagnosis of a primary cerebral hydatid cyst is uncommon even in a country (Australia) where hydatid cyst is relatively common. Symptomatology usually implies only the presence of a space-occupying lesion causing increased intracranial pressure; however, the disease should be suspected in such a picture seen in a child referred from a sheep-raising district. If one is not aware of this possibility, the intracranial field may be sprayed with scolices through performance of a ventriculogram or improperly planned operation. Therefore, if hydatid cyst is suspected, air studies should not be carried out and localization should be made from the clinical picture. There is no objection to following the postoperative course with encephalograms after the cyst has been completely removed.—*Herbert Lobsenz, M.D.*

INGRAHAM, F. D., BAILEY, O. T., and BARKER, W. F. Medulloblastoma cerebelli; diagnosis, treatment and survivals, with a report of 56 cases. *New England J. Med.*, Feb. 5, 1948, *238*, 171–174.

In 1925 Bailey and Cushing described medulloblastoma cerebelli as a midline cerebellar glioma of childhood characterized by rapid growth, abrupt onset of increased intracranial pressure, and cerebellar dysfunction. It is now well known that medulloblastomas are far better treated by irradiation than by radical surgery, but the optimum radiation dosage and the role of surgery remain to be more precisely evaluated.

Fifty-six patients with histopathologically verified medulloblastoma cerebelli, seen at the Children's Hospital (Boston) and the Peter Bent Brigham Hospital since 1930, were reviewed. Eighteen were in the first five years of life; 24, in the second five years. However, typical tumors were seen in patients as old as thirty-seven and sixty-five years.

Although 41 tumors occupied the classic midline cerebellar location, 10 were in the pons and pontine angle, and 5 were in the cerebellar hemispheres. The average age of patients with midline and hemisphere tumors was 7.5 years; that of the pontine and angle tumors, 16.1 years.

Symptoms had been present for an average of three months before hospitalization. While the clinical picture is usually characteristic, benign or radioresistant posterior fossa tumors may mimic the pattern often enough to make biopsy important before roentgen therapy is begun.

Posterior fossa exploration was carried out in 53 cases. Surgical measures consisted of biopsy, removal of tumor bulk if convenient, and re-establishment of cerebrospinal fluid drainage when necessary by a Torkildsen tube in children, or by third ventriculostomy in adults.

Nineteen cases showed characteristic extension to subarachnoid spinal and cerebral pathways. Those with spinal metastases usually showed cord symptoms, including segmental pain, cord bladder, paraplegia, or Horner's syndrome.

Seven of the 56 patients survived three years; only 3 of the 7 survived five years; 1 patient still living twenty-two years after her original admission. Analysis of survival according to type and amount of treatment shows the marked effectiveness of roentgen therapy in prolonging life and affording comfort in this extremely malignant tumor. Seventeen patients received no roentgen therapy, with an average total survival time of 0.3 months. Six received an undetermined amount of roentgen therapy, with an average survival of 7.4 months. Nine received 150–2,850 r, with an average survival of 7.6 months. Fifteen received 4,500–9,600 r, with an average symptom-free interval of 24.0 months, and average survival of 31.6 months. Nine received 10,800–30,000 r, with an average symptom-free interval of 44.6 months, and average survival of 54.0 months. The authors emphasize that although the larger doses of radiation may be assumed to be the cause of the longer survival, it is also true that only those patients who lived a relatively long time after admission could accumulate the large doses.

Leukopenia occasionally required interruption of treatment. Most patients suffered from post-therapy vomiting, and 1 died of acute cerebral edema after one treatment of 150 r. Despite the large doses given (up to 30,000 r to the skull and spine over three and a half years), no degenerative changes in the central nervous system were observed.

The authors conclude that the present management of choice begins with immediate exploration as soon as the diagnosis of posterior fossa tumor is made, in order not to jeopardize the vision of children who have a benign cerebellar tumor. The tumor is biopsied at operation, and a larger portion of the tumor resected if possible, and a means for circulation of cerebrospinal fluid is provided if necessary. As soon as the wound has healed, the patient is given intensive radiation therapy to the skull and spine, to a dose of approximately 5,000 r. The cerebellar portals are given an additional course in six months, sooner if necessary. Re-exploration is indicated if obstruction to cerebrospinal fluid drainage appears or recurs; a Torkildsen tube is used in younger patients, but a third ventriculostomy may be effective in adults.—*Henry P. Brean, M.D.*

NECK AND CHEST

WARD, R. Cancer of the thyroid. *California Med.*, March, 1948, *68*, 170–172.

The classic signs of advanced thyroid cancer —rapid growth, fixation, hoarseness, and dysphagia—are signs of impending death. Recognition of early cancer of the thyroid, however, is difficult, and often impossible by clinical means. Carcinoma is not common in diffuse toxic goiter, or in diffuse non-toxic thyroid enlargements of adolescence or pregnancy. In nodular goiters, on the other hand, malignancy is common, particularly in men, in children, or where the nodule is solitary. More than 20 per cent of nodular goiters in children under fifteen may be malignant. In adults, about 5 per cent of clinically benign nodular goiters prove to be malignant on pathological examination, and the percentage is much higher if the thyroid mass is solitary. In men, more than 10 per cent of multinodular goiters prove to be malignant, although nodular goiter is six to ten times more frequent in women. In a large clinic series, there was 1 cancer in each 8.3 males with nodular goiter, and in another series 1 malignancy to each 6 male patients.

Since the prognosis for cure and survival is highest for those patients in whom malignancy is discovered only on pathological examination, and lowest for those in whom malignancy is already suspected clinically, surgical removal should be advised for those patients with nodular goiter who fall into the groups with relatively high likelihood of malignancy. These are the solitary nodules, nodular goiters in men, and nodules in children.

One is therefore justified in advising operation for all men with nodular goiters; for all patients, male or female, with solitary tumor of the thyroid; for all children with nodular goiter; and for all patients who show recent increase in size, pressure symptoms, or dysphagia in long-standing nodular goiters.

Surgically, the nodule should not be simply enucleated, but the involved lobe should be excised. If biopsy shows a papillary carcinoma, the bulk of the tumor should be removed, followed by roentgen therapy. If anaplastic malignancy is demonstrated, the author is

pessimistic over the possibility of cure, doubting the value of radical operation and questioning the value of even palliative irradiation. The presence of discrete lymph node metastases, however, should not in itself contraindicate an attempt at surgical and radiotherapeutic cure, as these are often papillary carcinomas responsive to roentgen therapy.—*Henry P. Brean, M.D.*

KJELLBERG, SVEN ROLAND. A previously unreported sign of foreign bodies in the trachea. *Acta radiol.*, 1948, *29*, 300–302.

If a non-radiopaque foreign body is present in the trachea and the usual signs of bronchostenosis are lacking or are uncertain or insignificant, the roentgenological diagnosis then becomes much more difficult. In such cases a sign which depends on the softness of the tracheal cartilaginous rings in small children can be of great help. If a foreign body is lodged in the trachea, on inspiration the trachea below the foreign body becomes considerably dilated, especially the larynx and pharynx. On expiration, the lower portion of the trachea, on the contrary, either widens slightly or returns to normal width, while above the foreign body, the air passages become of normal or possibly narrower than the normal width.—*Mary Frances Vastine, M.D.*

NIELSEN, KAREN. A case of multiple tracheal diverticula. *Acta radiol.*, 1948, *29*, 331–334.

Tracheal diverticula can be divided in the following groups:

1. Those which are supposed to be congenital. They are always situated on the right side of the trachea at the site of the tripartition of the bronchial tree. They always extend obliquely down and outwards and are shaped like a short cylindrical tube. It is presumed that they are rudimentary bronchi.

2. Flask-shaped diverticula which usually have a narrow inlet. These are usually found in the middle third of the trachea to the right at the junction of the cartilaginous and membranous portions. Usually they are small and are often multiple. As a rule, they contain a viscid mucus. This type has never been found in children. They probably result from the retention of mucus in the paratracheal glands or from increased intratracheal pressure.

3. Diverticulum-like groove-shaped protrusions of the posterior tracheal wall. These diverticula are delimited by transverse crescent-shaped mucous membrane folds connecting the ends of the cartilage posteriorly. The trachea is usually dilated. There is atrophy of the elastic muscular tissue. These diverticula are usually seen in adults who have suffered from chronic respiratory tract diseases.—*Mary Frances Vastine, M.D.*

MAURER, ELMER, and DESTEFANO, GEORGE A. Eosinophilic granuloma of rib. *J. Thoracic Surg.*, June, 1948, *17*, 350–356.

Solitary eosinophilic granuloma may simulate bone cyst, giant cell tumor, Ewing's tumor, solitary myeloma, osteogenic sarcoma and osteomyelitis. Multiple lesions may present the same findings as multiple myeloma, metastatic tumor, osteitis fibrosa cystica, Letterer-Siwe disease and Hand-Schüller-Christian disease.

Approximately 39 cases of eosinophilic granuloma have been reported to date. Only 6 of these lesions have been solitary in the rib. The following case of a sixteen year old boy with a clinical history and roentgenologic findings consistent with osteogenic sarcoma is reported. Pain in the left chest was the only symptom complained of. A destructive, expansile process involving the posterior 9 cm. of the fifth rib on the left was seen on the roentgenogram. Pleural thickening about the lesion was noted. This seemed to favor an infectious process, such as osteomyelitis, while the bone destruction and expanding character of the tumor suggested a primary rib sarcoma. Giant cell tumor was also considered in the differential diagnosis. The diagnosis of eoisnophilic granuloma was made from the surgical specimen removed.

The roentgenographic appearance, pathology, treatment and prognosis of eosinophilic granuloma is discussed.—*Frederick M. Reis, M.D.*

LLOYD, MILTON S. Tumors of the anterior mediastinum; report of six cases. *Dis. of Chest*, May-June, 1948, *14*, 396–414.

The author reports in detail with roentgenograms of 6 cases of which 5 were treated surgically. These included 3 teratomas, one each lipoma, lymphangioma, and "undifferentiated" tumor of newborn. The importance of roentgen examination for early diagnosis is stressed, as well as prompt surgical intervention before the

cysts become infected or ruptured.—*Fred R. Gilmore, M.D.*

SODEMAN, W. A. Pulmonary heart disease. *Dis. of Chest*, May-June, 1948, *14*, 360–365.

The author collected 123 cases of cor pulmonale for analysis of pulmonary hypertension due to pulmonary disease per se: 75 cases of emphysema, 14 bronchial asthma, 9 tuberculosis, 8 silicosis, 7 bronchiectasis, and 5 silicotuberculosis. These conditions cause a change in the alveolar pressure so as to increase resistance of blood flow to the lungs. The pulmonary fibrosis, compensatory polycythemia, and overfilling of the heart are secondary aggravating factors. The clinical picture is described with distended neck veins, hepatomegaly, prolonged circulation time, and dependent edema, as well as dyspnea, cough, and hemoptysis. Cyanosis is a serious sign of early failure. The usual studies involve electrocardiogram, hemodynamics, and other laboratory procedures. Roentgenographic and fluoroscopic evidence of right ventricle enlargement with prominent pulmonary conus may be seen on the oblique views long before other evidence of cardiac enlargement. Only 4 of 15 cases with a single posteroanterior film showed suspicious evidence of cor pulmonale.—*Fred R. Gilmore, M.D.*

GUBERGRITS, A. YA. Occult injuries to the heart. *Am. Rev. Soviet Med.*, Dec. 1947–Jan. 1948, *5*, 61–63.

This communication deals with 26 cases and consequences of lodged foreign bodies in the heart. Splinters were localized in the great vessels in 2 cases and in the cardiac musculature in 24 cases. In no case was the foreign body found in the cavities of the heart.

The author feels that fluoroscopy is the diagnostic method of choice in foreign body injuries of the heart and it is superior to roentgenography. It should be performed routinely, slowly turning the patient about an axis of 360°. It is essential to determine whether the foreign body is situated within a cavity, or in the wall, or whether it lies near the cardiac shadows. If it lies in the muscle or near the cardiac shadow the splinter shows movements synchronous with systole and diastole. If the foreign body lies in one of the heart cavities it makes whirling movements as a result of the blood current. Such cases have been reported. There may be very little reduction in the working capacity of these patients.

In most cases no absolute indication exists for removal of a metal splinter from the heart. Surgical intervention may be justified when a purulent infection occurs in the area of the foreign body or when a beginning migration implies danger.—*R. A. Butz, M.D.*

THOMAS, S. F., and GARLAND, L. H. Roentgen cardiac kymography; electrocardiographic correlation. *California Med.*, March, 1948, *68*, 126–129.

Introduction of single slit roentgen kymography by Sabat in 1911, and perfection of the multiple slit method by Stumpf in 1928, have made available a technique for permanently recording the pulsations of the heart and great vessels. In order to evaluate one aspect of the reliability of roentgen kymography in diagnosis, the authors correlated the kymographic findings of 249 cases with the electrocardiograms.

Using a conventional kymograph with multiple 0.4 mm. slits and a film excursion of 12 mm., exposures of 1½ to 2 seconds were made in mid-inspiration at as near neutral respiratory pressure as possible. Criteria for kymographic diagnosis of myocardial abnormality included decreased height of wave, sharpening or splintering of peak, and suppression or paradoxical reversal of local movement.

Average age of the cases was thirty-eight years; for those with a clinical diagnosis of coronary artery disease or hypertension, it was 44.5 years. The group comprised patients with suspected or known cardiac disorder, ranging from functional disturbances to myocardial infarction.

Roentgen kymographic and electrocardiac diagnoses correlated well in 80.5 per cent of the cases, or 201 patients. In this group, both methods were positive in 11.3 per cent, negative in 58.4 per cent, and questionable in 10.8 per cent. There was failure of correlation in 48 cases, or 19.5 per cent. Twenty of the failures were unequivocal disagreements, and probably represent inherent error in either method of examination. In the other 28 cases of lack of correlation, one of the methods was questionable while the other was positive or negative, and the lack of correlation therefore not clear-cut. The authors point out that, if it is assumed the findings in this last category of uncertain correlation may still have been of clinical value

in arriving at a diagnosis, the over-all figures result in an error of less than 10 per cent.

Kymograms of 4 illustrative cases are shown, 1 demonstrating a pathologically verified myocardial infarct in which the electrocardiogram was negative. Films of two other myocardial infarcts, and of a stab wound of the heart, are also presented.

Properly interpreted roentgen kymograms, therefore, are a reliable source of information supplementing clinical and conventional roentgenologic methods. Occasionally they provide data not obtainable clinically or electrocardiographically. Roentgen kymograms may supply important diagnostic information in suspected myocardial disease when the electrocardiogram is inconclusive or even negative.—*Henry P. Brean, M.D.*

WALD, B. Contributions on the roentgenology of the left auricle. *Acta radiol.*, 1948, *29*, 335–342.

Direct roentgenological representation of the posterior wall of the left auricle cannot be afforded because this portion of the heart has no surface of contact with the air-containing lung. The author demonstrates by both anatomic and roentgenological investigations that the outline of the heart shadow on the right, when confined to the right anterior oblique position, is always formed by the right auricle and not by the left one. The upper portion of the right border of the heart shadow may protrude in the right anterior oblique position should pathological enlargement of the left auricle occur. Such protrusion is caused not by alterations in the posterior wall of the left auricle but by expansion of the heart directed ventrally and to the right.—*Mary Frances Vastine, M.D.*

SINGER, JACOB J. Bronchiectasis. *Dis. of Chest*, Jan-Feb., 1948, *14*, 92–106.

The author outlines the salient features of bronchiectasis. The most common etiological agents are nasal sinus disease associated with pulmonary findings, and silicosis. It is classified in two forms; congenital, and acquired bronchiectasis. The first is noted with cysts, and congenital malformations, while the second usually follows exanthomatous diseases, foreign bodies, and tumors. The clinical symptoms of cough, expectoration, and hemoptysis are correlated with the pathological processes. The role of roentgen diagnosis is stressed in differentiating the various bronchiectatic dilatations: grape, clubbing, cylindrical, saccular, and bead formation. The author outlines various methods of bronchography using iodized oil and warns of the infrequent allergy, iodism, which usually subsides in several days, and the rare atelectasis due to an oil-blocked bronchus. He concludes the modern medical and surgical treatment by stating that the only effective cure is surgical removal of the diseased portion of lung.—*Fred R. Gilmore, M.D.*

SKELETAL SYSTEM

SCHLEICHER, EMIL MARO. Miliary tuberculosis of the bone marrow. *Am. Rev. Tuberc.*, Feb., 1946, *53*, 115–121.

Data derived from postmortem material and from terminal and known cases of pulmonary and generalized miliary tuberculosis showed that tuberculosis affects the bone marrow frequently enough to justify the use of the sternal aspiration method as a means of detecting the disease early. The use of a standard sternum needle makes the method a simple and safe procedure. The author has not observed any serious injury to the bone. Serial aspirations can be done at short time intervals without great discomfort to the patient. Thus the possibility is open to obtain information with respect to the course of the disease and by the same token the effectiveness of chemotherapeutic agents may be studied in man. Aspirated sternal marrow can be directly innoculated into a guinea pig, cultured, imprinted or smeared on a glass slide for the demonstration of the tubercle bacillus.—*James J. McCort, M.D.*

KNUTSSON, FOLKE. Two synovial fibrosarcomas (Jönsson). *Acta radiol.* Jan., 1948, *29*, 4–6.

In his doctor's thesis Jönsson has clarified the nomenclature of malignant tumors arising in joint capsules, tendon sheaths, and bursas. He divides these malignant synovial tumors into two different groups, namely synovialomas and synovial fibrosarcomas. These two kinds of tumors show both clinical and micro-anatomical differences. The synovialomas are more malignant and often metastasize to the regional lymph glands, the lungs and internal organs. The synovial fibrosarcomas, on the other hand, very seldom metastasize to the lungs and other

internal organs. The synovialomas, as distinct from the fibrosarcomas, are very responsive to roentgen treatment.

The fibrosarcomas sometimes contain calcifications causing them to have a roentgen diagnostic interest. The author describes 2 cases of synovial fibrosarcoma. In the early stages, the synovial fibrosarcoma is usually interpreted as an inflammatory process. There is extreme tenderness but no spontaneous ache. Surgical intervention and roentgen treatment are necessary. There is a risk of local recurrences and remote metastases.

In his 2 cases, the author could ascertain the diagnosis through the characteristic calcification. The calcifications consisted principally of sharp-edged shards which proved they were part of the tumor structure. Calcium precipitation in a necrotic tissue would have a more uncharacteristic, amorphous appearance.—*Mary Frances Vastine, M.D.*

Westerhorn, Anders. Marrow nailing of recent fractures, pseudarthrosis, and bone plastic experience in 100 cases. *Ann. Surg.*, April, 1948, *127*, 577–591.

In this excellent paper the relatively new method of fixation of long bone fragments by intramedullary nailing is well demonstrated with the apparatus used and with illustrative cases for each type of orthopedic problem it best serves. The author is very encouraged with his results. In his opinion it represents an important advance in treatment of fractures of the femur as nailing of hip fractures. The intramedullary nails are made of stainless steel of several widths and ranging in lengths from 10–45 cm. The nails are thin and V-shaped but of good quality steel so although flexible they will not bend. The advantages of this construction permit firm fixation in the marrow cavity and minimum involvement of the marrow and endosteum by the nail surface. Special tools are required for both the insertion and removal of these nails.

In fractures of the femur the nail can be inserted directly through the soft bone of the upper surface of the greater trochanter. However, in the humerus, radius, ulna and tibia a small hole must be made in the cortex some distance from the fracture site. In the actual procedure it is essential to have close apposition of the fragments to permit direct threading of the nail from one portion of the medullary cavity to the next. Empirically it was found best to use a leader in the form of a Kirschner wire. This is done under fluoroscopic control or using multiple films. In judging the size of the nail to use, at 75 cm. focal distance the marrow is actually 1 mm. smaller than it appears on the roentgenogram. Although the marrow cavity of the femur is symmetrical it has been found that the central portion of the tibial marrow cavity is the narrowest so in fractures of the proximal and distal thirds of the tibia firm fixation is difficult to obtain. The dangers of intramedullary nailing include marrow destruction, fat embolism and osteomyelitis. Actually there is little marrow damage and the nails are removed once the fracture is solid. Fat embolism has not definitely been proved to result from the nailing procedure or the fracture site itself. To date the experience with infection has been unusual in that the patients with open wounds have done well with naiiing. In those cases where the nail was removed because of osteomyelitis the infection became worse. The author believes the nail permits the pus to drain off.

The advantages of intramedullary nailing in fractures and pseudarthrosis are: (1) very firm fixation of the fragments with close apposition, (2) shortened bed stay, (3) early weight bearing, (4) reduced pain, and (5) less in the way of secondary change due to long immobilization, i.e., stiff joints, muscular atrophy and circulatory disorders.—*T. D. Allison, M.D., and C. L. Hinkel, M.D.*

Colson, G. M., and Willcox, A. Phalangeal metastases in bronchogenic carcinoma; report of three cases. *Lancet*, 1948, *1*, 100–102.

This is a report of 3 cases seen at the Middlesex Hospital. In all 3 cases the phalangeal metastases closely resembled, clinically, an inflammation and were at first assumed to be a paronychia, Whitlow or infected bunion. Roentgenography revealed the true nature of the lesion and biopsy confirmed its origin.

In two cases the phalangeal symptoms appeared six and eight weeks before the clinical signs of pulmonary involvement.

The cause for this unusual metastasis is thought to be the easy access of the bronchial growth to the pulmonary veins, thence to the systemic arteries.—*J. S. Summers, M.D.*

LENNON, WILLIAM, and CHALMERS, ISABELLA. Ankylosing spondylitis. *Lancet*, 1948, *1*, 12–15.

This is a report of 32 cases seen at the Rheumatic Unit, Royal Free Hospital, London, in a twelve month period. They found the commonest age of onset to be the third decade. One case started at 11 years of age, 6 cases at 15–20, 14 cases at 20–30, 9 cases at 30–40 years, 1 case at 40–50 years and 1 case at 50–60 years. These cases were of all types of physique and not necessarily confined to the virile athletic type as suggested by some writers. They could find no definite association between this disease and "septic foci."

The authors believe that the early roentgen changes in the sacroiliac joints are the key to early diagnosis even in the absence of clinical findings (2 cases). They find much relief of pain and stiffness from roentgen therapy, but can draw no conclusions as to its altering the ultimate course of the disease.—*J. S. Summers, M.D.*

BLOOD AND LYMPH SYSTEM

SYMMERS, DOUGLAS. Lymphoid diseases. *Arch. Path.*, Jan., 1948, *45*, 73–131.

This paper is an excellent review of the lymphoid diseases grouped into Hodgkin's disease, giant follicular lymphadenopathy, lymphoid leukemia, lymphosarcoma, and gastrointestinal pseudoleukemia of Briquet. There is an extensive discussion of the etiology, pathological aspects, symptoms and signs, diagnosis and treatment of each disease. The paper is recommended to the reader in the original. The author emphasizes that all these diseases are initiated by hyperplasia of the lymph follicles and that they are primary in the deep lymphoid structures, seen only in the superficial nodes as a late and secondary finding. The theories concerning the etiology and nature of Hodgkin's disease remain unsettled. Symmers is convinced that the majority of the evidence favors the disease as an infective process. The opposing view is that it is a primary cancer of lymph nodes. The author's theory includes that Hodgkin's disease is a process of myeloidization of lymphoid structure with embolism of megakaryocytes from the marrow as instigating factors. A related theory was advanced by Medlar in that Hodgkin's disease is a primary malignancy of the bone marrow with megakaryocytoblasts metastasizing to the lymphoid structure.

Giant follicular lymphadenopathy usually pursues a benign course for long periods. It is markedly radiosensitive throughout most of its course. Cases of transformation into Hodgkin's disease or lymphoid leukemia have been recorded with rapid terminal sequences.

The classical course of lymphoid leukemia remains remarkably constant in most cases. However, two general groups exist, namely (1) the lymph nodes are generally enlarged and the spleen remains normal or relatively so, and (2) the situation is reversed with a huge spleen and little lymph node enlargement.

The parallelism of lymphosarcomatous lesions in dogs caused by a virus is discussed with reference to human cases of lymphosarcoma. Lymphosarcoma presents a complex clinical picture and the cases are grouped into five categories: (1) involvement of paired organs, (2) superficial nodes in localized areas, (3) intrathoracic collections of lymphoid tissue with involvement of the thymus, (4) leukosarcoma which terminates in acute lymphatic leukemia, and (5) involvement of the lymphoid tissues of the abdomen including gastrointestinal tract and regional nodes—both retroperitoneal and mesenteric.

The cases of gastrointestinal pseudoleukemia of Briquet with marked lymphoid hyperplasia extending from the tongue throughout the gastrointestinal tract to the anus are regarded as a form of lymphosarcoma although they lack the infiltrative and destructive features of a true neoplasm.—*T. D. Allison, M.D., and C. L. Hinkel, M.D.*

GARDNER, L. B. Cooley's erythroblastic anemia in two Chinese boys. *J. Pediat.*, Sept., 1947, *31*, 347–354.

A few cases of Cooley's anemia have been reported in patients of families not native to lands adjacent to the Mediterranean Sea. One previous case has been reported in a Chinese child. The author reports 2 cases in Chinese boys.

The first patient was eight months old on first admission. Laboratory studies of the blood demonstrated typical erythroblastic anemia. Clinically the child showed pallor, a cardiac murmur, splenomegaly and hepatomegaly. The roentgen findings on first admission were not conclusive. A splenectomy was performed. On

the last admission of several, four years later, a definite increase in thickness of the frontal bones was demonstrable by roentgen ray as well as pronounced trabeculations of the bones of the hands.

The second case was a three year old Chinese male infant who exhibited marked pallor, splenomegaly and hepatomegaly. Roentgenograms of the skull showed thickening of the frontal area and generalized mottling of the calvarium. Roentgenograms of the hands showed cortical thinning and coarsening of the trabecular pattern. Laboratory studies showed erythroblastic anemia.—*Rolfe M. Harvey.*

Prinzmetal, M., Ornitz, E. M., Jr., Simkin, B., and Bergman, H. C. Arterio-venous anastomoses in liver, spleen, and lungs. *Am. J. Physiol.*, Jan., 1948, *152*, 48–52.

The authors utilize a technique previously described by them of arterial injection and venous recovery of microscopic glass spheres in studying arteriovenous anastomoses of various organs.

In the present experiments dogs, rabbits and cats were employed. Spheres injected into the portal vein, splenic artery, and right ventricle and pulmonary artery were recovered from the lungs, liver and splenic vein and liver and pulmonary vein respectively. The size of the recovered spheres of greater than the maximum capillary diameter was taken as a measure of the caliber of the arteriovenous shunts in the organs studied. These range from 50 to 180 microns in the liver, 160 to 380μ in the spleen and 100 to 390μ in the lungs.—*L. Feder, M.D.*

GENERAL

Cone, Ross B. A review of Boeck's sarcoid with analysis of twelve cases occurring in children. *J. Pediat.*, June, 1948, *32*, 629–640.

Boeck's sarcoid is a specific chronic infectious disease of unknown etiology which may affect any organ of the body, although commonly involving the skin, lymph nodes, eyes, salivary glands, lungs and bones of the hands and feet. The skin lesions show more chronicity than the extracutaneous lesions which tend toward spontaneous regression.

Among the theories as to etiology are an anergic form of tuberculosis, a mycobacterium and a virus. The microscopic picture strongly resembles tuberculosis. Central necrosis of the tubercles is rare. Acid fast bacilli are rarely found.

The onset of the disease is insidious, with skin or lymph node involvement in 50 per cent of the cases and mild fever. Among other systems involved by the disease, in addition to the skin and lymphatics, are the eyes, lungs, heart, central nervous system, gastrointestinal tract and bones. The author discusses the changes produced in each of these systems in some detail.

Ten to 20 per cent of patients have involvement of the small and long bones of the hands and feet. The roentgen changes consist of trabeculations and cyst formation with sharply punched out areas and little evidence of reaction in the surrounding bone.

The lung roentgen changes are of three types:

1. Peribronchial fibrosis and thickening, extending downward symmetrically into the lower lobes.
2. Soft infiltration in the mid-lung fields sparing the apices.
3. Areas resembling miliary tuberculosis.

Lymphadenopathy is often present in the tracheobronchial and mediastinal nodes.

The author summarizes the positive findings in a group of 12 children, affected with sarcoidosis, admitted to the Duke Hospital. Only 1 of the 12 cases failed to show the typical lung changes by roentgen ray. Fifty per cent had bone changes roentgenologically.—*Rolfe M. Harvey, M.D.*

Schwartzman, J., Maffia, A., Crusius, M. E., and Brunhoffer, A. Congenital toxoplasmosis. *J. Pediat.*, July, 1948, *33*, 66–73.

The *Toxoplasma* is a protozoan parasite which has an affinity for the central nervous system. It has not been frequently reported in humans. It has been found to cause an acute encephalitis in older children and pulmonary infections in adults, as well as the originally reported infantile cases. The infection may be acquired in utero. The typical case has the following characteristics:

1. Infection in utero or shortly after birth with symptoms at birth or shortly after.
2. Signs of central nervous system injury such as tremors, spastic contraction of the extremities, convulsions, microcephalus, hydrocephalus, and mental retardation.
3. Ocular signs, especially chorioretinitis.
4. Roentgen evidence of intracerebral cal-

cification, often bilateral, involving the cerebral cortex and basal ganglia.
5. Xanthochromia, round cell pleocytosis and high proteins in the cerebrospinal fluid.
6. Recovery of *Toxoplasma* from body fluids of mice or rabbits by direct smear or inoculation.
7. Demonstration of *Toxoplasma*-neutralizing antibodies in blood of infant or mother.

The pathological findings are those of focal areas of inflammation and necrosis with miliary granulomas tending to calcify. Therapy is not efficacious.

The authors report the case of a seventeen month old Negro infant suffering from weight loss and mental retardation. The head was microcephalic. A roentgenogram of the skull showed diffuse areas of calcification distributed intracerebrally. Ophthalmoscopic examination showed diffuse bilateral chorioretinitis. Laboratory tests were negative. This is the first case of toxoplasmosis reported in which dwarfism was present.—*Rolfe M. Harvey, M.D.*

STOUT, ARTHUR P. Mesenchymoma, the mixed tumor of mesenchymal derivatives. *Ann. Surg.*, Feb., 1948, *127*, 278–290.

While for a number of years data have been accumulating on specific cell types of mesenchymal neoplasms such as liposarcoma, synovial sarcoma, rhabdomyosarcoma, etc., there are other mixed tumors of mesenchymal derivatives which have received little attention. Most of these are believed to result from dysontogenesis.

The author suggests the name mesenchymoma for this group of tumors and divides them into benign and malignant. There have been reported a number of such malignant neoplasms in the urogenital tract and breast; but this paper points out they can readily occur elsewhere and describes 8 cases. These cases show a great range in histopathologic composition with 2 of the cases containing five mesodermal types of neoplasms. Early and extensive resection is necessary for these tumors as they are markedly radioresistant.—*T. D. Allison, M.D., and C. L. Hinkel, M.D.*

ROENTGEN AND RADIUM THERAPY

GRAHAM, VINCENT P., and MEYER, RALPH R. Experiences with nasopharyngeal carcinoma. *Radiology*, Jan., 1948, *50*, 83–91.

Twenty-six cases of carcinoma of the nasopharynx are reviewed. In 62 per cent superior cervical node metastases were present and in 56 per cent of all the cases there was involvement of the fifth and sixth cranial nerves. Recurrent middle ear disease was a frequent symptom.

In all cases the rhinoscopists were able to visualize a nasopharyngeal mass or ulcer. The lateral view of the nasopharynx was useful to demonstrate a soft tissue mass, but seldom showed bone destruction. In 17 of 24 cases stereoscopic verticomental basal or axial views of the skull showed varying degrees of destruction of the petrous apex and medial portion of the greater wing of the sphenoid. This bone destruction is believed to be due either to direct invasion of bone by tumor or to pressure atrophy. The great majority of such tumors are epithelial in origin.

The average patient received a calculated tumor dose of 5,000 r within forty days through two lateral nasopharyngeal fields, each of which received 3,600 r skin dose, and one anterior facial field which received 1,500 r skin dose delivered with 200 kv. (peak) irradiation. The large lateral parts which include the regional lymph nodes are usually reduced to a 10×10 or 6×8 cm. field when the course is half completed, unless these nodes are positive for disease in which case the fields remain large—10×20 cm.

Good palliation and prolongation of life was obtained in almost all cases and a five year cure was obtained in approximately 20 per cent. An occasional patient lives for ten to twelve years following the onset of disease.—*Howard R. Crews, M.D.*

LAING, DONALD R. The roentgen treatment of subacute sinusitis in children. *Radiology*, Jan., 1948, *50*, 52–56.

In children an upper respiratory infection lasting for more than five days requires investigation of the tonsils, adenoid tissue, paranasal sinuses and allergic tests. The tonsils may be inspected visually and nasal secretions stained for eosinophils. Adenoid infection is difficult to evaluate since this region is relatively inaccessible, especially in children. Sinus infection may frequently be detected by a single view of the sinuses and is a relatively simple diagnostic procedure.

Sinusitis in children is difficult to treat by the usual procedures, since children do not tolerate

nasal packs or antral irrigations. Nine hundred children believed to have subacute sinusitis were treated with irradiation. These patients were treated through an anterior port, 8 or 10 cm. in diameter with lead eye shields. The lung roots were treated through a posterior 8 or 10 cm. port if cough was a predominant symptom. Treatment was also administered to each lateral nasopharynx through a 7 cm. field if there was impaired hearing or a history of intermittent ear ache. These patients received three treatments to each area, 80 r per treatment at three day intervals with 140 kv. (peak) therapy.

Of 900 patients treated, 71 per cent were cured after one course. Fifteen per cent showed moderate improvement following the first course and 55 per cent of these were cured by a second course of treatment. Fourteen per cent responded poorly and it is believed that these patients suffer from undiagnosed allergy.—*Howard R. Crews, M.D.*

Beckstrand, Grant. Palliative procedures in advanced cancer of the mouth. *Radiology*, Jan., 1948, *50*, 10–17.

The palliative management of patients with advanced cancer of the mouth is discussed.

These patients require general medical care as well as local treatment directed towards the relief of pain and control of infection. Local procedures and general health measures are discussed in detail. Palliative irradiation should be used as an adjunct to general care primarily to combat infection and retard tumor growth. Intensive irradiation may defeat its purpose by producing a vigorous local reaction with systemic ill effects.—*Howard R. Crews, M.D.*

Erskine, Arthur W. The management of advanced cancer of the breast. *Radiology*, Jan., 1948, *50*, 7–9.

Advanced cancer of the breast is usually divisible into two distinct groups.

In the first group the disease is local and usually ulcerated with fixation to the chest wall with or without axillary disease. Surgery is preferred when there is a reasonable chance for cure. The primary tumor may be removed and the defect covered with skin from the unaffected breast or elsewhere. In patients past sixty or seventy these tumors may be treated successfully with irradiation; at least the patient may live out her normal life without unpleasant symptoms of advanced cancer. The most spectacular results of roentgen therapy are seen in such cases.

In the second group there are widely disseminated metastases with or without local ulceration. In such cases all hope for a permanent cure must be abandoned. Simple excision of the primary tumor is probably indicated if ulceration is present. Radiologists and surgeons should refrain from attempting extensive therapeutic procedures and confine their efforts to retard the spread of disease and to the relief of pain.

Castration is of great value in retarding the course of advanced cancer. Equally good results are produced by either surgical or irradiation induced castration.

Severe pain is usually due to bone lesions or to pressure on nerves. Roentgen therapy in small doses is of definite value in controlling pain. Opiates should be used when necessary.—*Howard R. Crews, M.D.*

Costolow, William E. Care of patients with advanced pelvic cancer. *Radiology*, Jan., 1948, *50*, 3–6.

Irradiation is the generally accepted treatment of cancer of the vagina and cervix and, in conjunction with surgery, of cancer of the fundus.

This paper is essentially a plea for careful radiation treatment and general management of patients suffering from pelvic cancer.

Intensive pelvic irradiation is a major therapeutic procedure and patients receiving such treatment should have the benefit of close cooperation of the family physician, radiation therapist, surgeon and urologist.

Pelvic inflammatory disease is the cause of the majority of complications and every attempt should be made to recognize and treat this complication before intensive radiation therapy is started.

The urinary tract should be thoroughly investigated before treatment since many patients with pelvic cancer have asymptomatic or unrecognized urinary complications.

Transitory irradiation reactions include proctitis and cystitis. These reactions respond to local medication. If severe, treatment may be temporarily discontinued.

Vesicovaginal and rectovaginal fistula and ureteral obstruction with resultant infection are invariably due to extension of pelvic cancer.

The neurosurgical procedures for the relief

of intractable pain are discussed. Such procedures are usually too formidable for the average case. Non-opiates and eventually opiates are recommended.—*Howard R. Crews, M.D.*

PUND, EDGAR R., NETTLES, J. B., CALDWELL, J. D., and NIEBURGS, H. E., Preinvasive and invasive carcinoma of the cervix uteri. *Am. J. Obst. & Gynec.*, May, 1948, *55*, 831–837.

Cervical squamous cell carcinomas usually begin in the endocervical canal at the junction of the stratified squamous and columnar epithelia. The source of these cancers is probably the endocervical basal cell whose location corresponds to that of the early cancer.

Three stages of cervical cancers are described: (1) preinvasive carcinoma; (2) covert invasive carcinoma; (3) overt carcinoma.

The term "preinvasive carcinoma" denotes carcinoma which is confined to the natural surfaces and which does not penetrate the underlying stroma.

Ultimately the preinvasive carcinoma becomes invasive. The invasion occurs either from a large surface of the endocervix or from a single focus. The early invasive carcinomas are not visible on vaginal examination and are therefore denoted as covert invasive carcinomas. Difference in average age of patients in the preinvasive and covert invasive groups suggests that the period of latency before the preinvasive carcinoma becomes invasive may average 6.5 years.

The overt carcinomas are readily suspected by vaginal examination. Since the authors have observed only 2 early carcinomas which were limited to the vaginal surface of the cervix, they conclude that the great majority arise from the junctional endocervix and are not evident until there is definite penetration and ulceration of the vaginal surface of the cervix.

From their study they believe that the majority of cancers of the cervix become obvious only after a period of time averaging five years from onset of invasion and eleven years after incipiency.

Concentration of effort should be directed toward detection of preinvasive carcinoma because therein lies the greatest opportunity for cure. It is important that biopsies include the junction of the squamous and columnar epithelia, and it should be emphasized that the existence of preinvasive carcinoma is frequently not detected by single biopsies. It is suggested that the endocervix and endometrial surface of the uterus be curetted before treatment is started to differentiate between preinvasive and covert invasive carcinoma.

The authors prefer to recommend irradiation for both covert invasive carcinomas and for overt carcinomas. They now recommend total abdominal hysterectomy in cases of preinvasive carcinoma with preservation of the ovaries in the young. At operation, if invasion is thought to be present, the uterus should be left in place, and, because irradiation will be subsequently used, surgical castration is recommended. Cauterization, conization, and amputation of the cervix as treatment for preinvasive carcinoma are discouraged.—*John R. Hannan, M.D.*

DRIPS, DELLA G. Ovarian dysfunction in young women treated with low-dosage irradiation. *Am. J. Obst. & Gynec.*, May, 1948, *55*, 789–798.

Since 1927 the author has been using low dosage roentgen irradiation for the "amenorrheic type" of ovarian dysfunction. In this type there is a tendency to larger than normal intervals between the menstrual periods and a decrease in the flow or complete absence of menstruation. Two distinct groups were recognized early in the study—one group had no complaints other than menstrual irregularity and a tendency to gain weight during periods of amenorrhea, and the other group had many complaints associated both with menstrual periods and their periods of amenorrhea. The symptomatology in the first group was considered to be secondary to pituitary failure and in the second group it was attributed to ovarian failure.

In pituitary failure the gonadotrophic hormone is usually not found in the urine, and when failure is complete there is, at least temporarily, an absence of estrogen. In cases of ovarian failure gonadotrophic hormone is found in greater than normal amounts and estrogen may or may not be found depending on the degree of failure.

Clinically cases of ovarian dysfunction due to pituitary failure outnumber those due to failure primary in the ovaries. There are two groups exhibiting pituitary failure—the one group has pituitary failure secondary to some general systemic disturbance and the other

group apparently has an endogenous pituitary dysfunction.

A normal basal metabolic rate is established with thyroid extract and cyclic administration of ovarian hormones, particularly estrogens, is attempted for several months before resorting to irradiation in the pituitary failure groups. The author recommends irradiation over each temporal region, centering over the pituitary, and two fields over the anterior abdomen, centering over each ovary. The technique used: 200 kv., 20 ma., 0.75 mm. Cu and 1 mm. Al filters, 50 cm. distance for five minutes. This represents approximately one-sixth of a skin erythema dose.

Response to low dosage irradiation has been best in the pituitary failure group, and the best results are attained when amenorrhea has been present less than six months because irreversible atrophy of the genital tract has usually not occurred.

In the cases of primary ovarian failure, thyroid extract, cyclic administration of estrogens and pelvic heat are used, and if these measures fail, low dosage irradiation is given and is limited to the ovaries. The technique of irradiation is otherwise the same as for primary pituitary failure.

The object of therapy in both groups is to establish more regular normal menses and to continue these until pregnancy can take place. One hopes also to relieve symptoms associated with abnormal menstruation. The results of low dosage radiation therapy in a group of 331 patients have been excellent. Low dosage irradiation is the best single method of treatment in cases of amenorrhea of more than one year's duration. Combined therapy—thyroid extract, estrogens and irradiation—has been somewhat more effective than low dosage irradiation alone. The author considers it unwise to treat women for sterility alone with low dosage irradiation.—*John R. Hannan, M.D.*

Johnston, James R., and Jacox, Harold W. Rectal hemorrhage following irradiation for carcinoma of cervix. *Am. J. Obst. & Gynec.*, May, 1948, *55*, 891–893.

Late intestinal complications following irradiation for pelvic malignancy are recognized and frequently anticipated. Degrees of damage to the distal colon vary from the mildest type causing simple proctitis, through stages of destruction terminating in atrophy, stenosis or perforation. These changes are often on a basis of telangiectasia or obliterative endarteritis. Rectal hemorrhage frequently responds to medical treatment and a colostomy is seldom required to control hemorrhage.

In the case reported by the authors, radiation treatment of the primary carcinoma of the cervix began in March, 1937. It consisted of 50 mg. focus of radium (details not known) applied for forty-eight hours (2,400 mg-hr.), and followed by a series of high voltage (200 kv., 0.5 mm. Cu) roentgen treatments. The patient received 1,600 r (air) to each of four pelvic portals 12 by 17 cm. in size over a period of sixteen days.

In September, 1937, a biopsy of the cervix showed papillary adenocarcinoma. Radium treatment was instituted and consisted of two 40 mg. capsules of radium (1 mm. platinum filter) tandem in cervix and fundus and four 10 mg. needles (0.5 mm. platinum) in the parametria for thirty hours, a total of 3,600 mg-hr. Ten days later a series of roentgen treatments was begun using the same technique as before and totalling 1,400 r to each of four portals over a period of fourteen days.

One year later severe rectal hemorrhage developed which ultimately required resection of the terminal large bowel. The resected specimen showed fibrosis with undifferentiated metastatic carcinoma in the submucosa. Thirteen months after resection of the rectum and distal sigmoid the patient developed a carcinoma of the ascending colon. Seven years after resection of this group the patient is well without evidence of recurrence of either neoplasm.—*John R. Hannan, M.D.*

MISCELLANEOUS

Graef, Irving, Karnofsky, David A., Jager, Val B., Krichesky, Boris, and Smith, Homer W. The clinical and pathologic effects of the nitrogen and sulfur mustards in laboratory animals. *Am. J. Path.*, Jan., 1948, *24*, 1–47.

The official War Department symbols designating the compounds under investigation are as follows:

H bis (β-chloroethyl) sulfide
HN_1 ethyl-bis (β-chloroethyl) amine
HN_2 methyl- bis (β-chloroethyl) amine
HN_3 tris (β-chloroethyl) amine
TL_{301} iso-propyl-bis (β-chloroethyl) amine

The results obtained in the study of HN_2 are presented in most detail, this compound being accepted as the prototype for this group of vesicants.

Dosage is expressed in terms of LD_{50}, an arbitrary statistical value. At this dosage 5 of 10 intoxicated animals may be expected to die.

The reported "clinical" effects were observed in mice, rats, rabbits and dogs.

There is an asymptomatic latent period of one to two days following LD_{50} doses of the nitrogen and sulfur mustards, during which time lymphatic injury is abrupt. The thymus, spleen and lymph nodes involute rapidly. There is a concomitant rapid reduction of the peripheral blood lymphocytes. The hemopoietic cells of the bone marrow show injury as does the epithelium of the small intestine.

Anorexia, weight loss and mucoid diarrhea follow the latent period, with death occurring in 72 to 144 hours. "The hemopoietic cells of the marrow disappear uniformly and the marrow becomes aplastic. The peripheral blood is severely leukopenic, due to a progressive fall in granulocytes. The red count falls slightly but reticulocytes disappear and it is evident that the production of hemopoietic cells has ceased. The small intestine is distended with fluid; and gastric stasis . . . is consistently present in small animals. From the pylorus to the cecum the small intestine shows inflammatory and degenerative changes, with hyperemia, edema of the villi, sloughing of the epithelium and metaplastic changes in the persisting and regenerating epithelium."

Rapidly occurring neurologic symptoms leading to death in one to forty hours follows large parenteral dosage. Convulsions, incoordination, tremors, weakness and dyspnea as well as parasympathomimetic activity occur.

Upper respiratory injury following gassing at LD_{50} concentrations is severe and prolonged with considerable systemic intoxication due to absorption.

Oral administration (the hydrochloride form of the compounds) produces the changes in the small intestine as noted above. A local protective action is apparently exerted by the presence of food in the gastrointestinal tract. Systemic intoxication occurs with absorption from the intestine.

Survival of animals following LD_{50} doses is characterized by gradual weight recovery, restoration of bone marrow and lymphoid tissue and a return of leukocytes in the peripheral blood. The lymphocytes return rapidly, the granulocytes more slowly. The diarrhea subsides and there is healing of the intestinal epithelium.

A distinct parallel exists between the delayed systemic effect of the nitrogen and sulfur mustards and that occurring after experimental roentgen irradiation.

Photomicrographs of representative tissue changes are appended.—*Victor Kremens, M.D.*

MALLET, LUCIEN. Radio-compteur pour particules ionisantes. (Counter for ionizing particles.) *J. de radiol. et d'électrol.*, No. 7–8, 1946, *27*, 359–361.

This short article describes a satisfactory counter for measuring alpha, beta and other ionizing particles. It should be of interest to those who are radiation physicists and who might be interested in constructing such a Geiger-Müller counter for themselves. A very adequate wiring diagram of the apparatus is shown. The stability of the counter is checked by a method using KCl, since potassium is a natural beta-ray emitter; a method using a uranium standard is also given. The technique for using the counter in measuring radioactivity (*a*) in a solution containing the radioactive substance, (*b*) in moist substances (radioactive viscera of experimental animals), and (*c*) in radioisotope separations is given. The sensitivity of the counter is of the order of 10^{-9} gr.—*William M. Loehr, M.D.*

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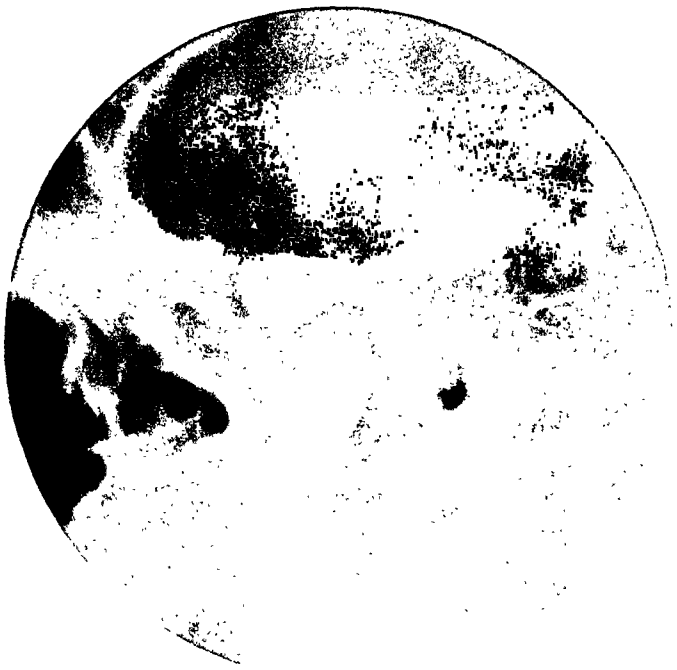
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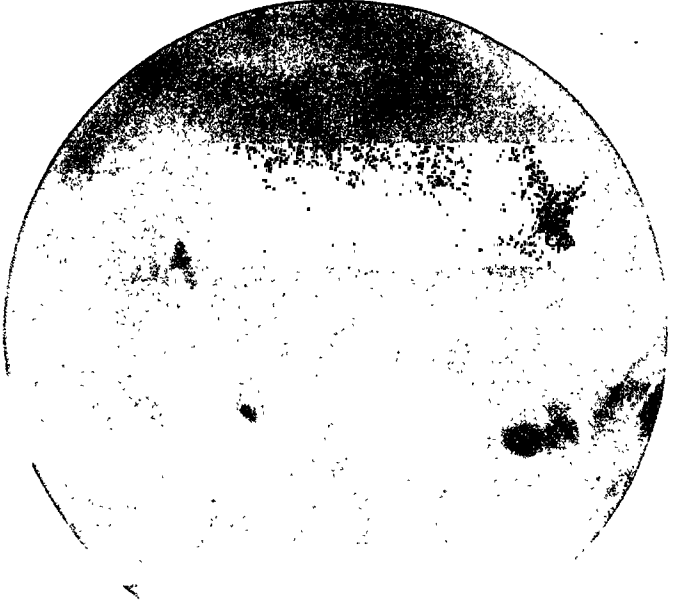
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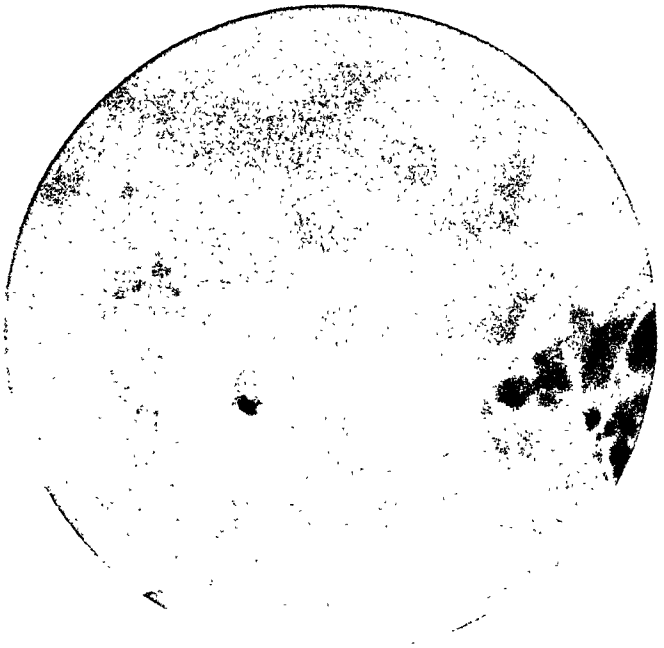
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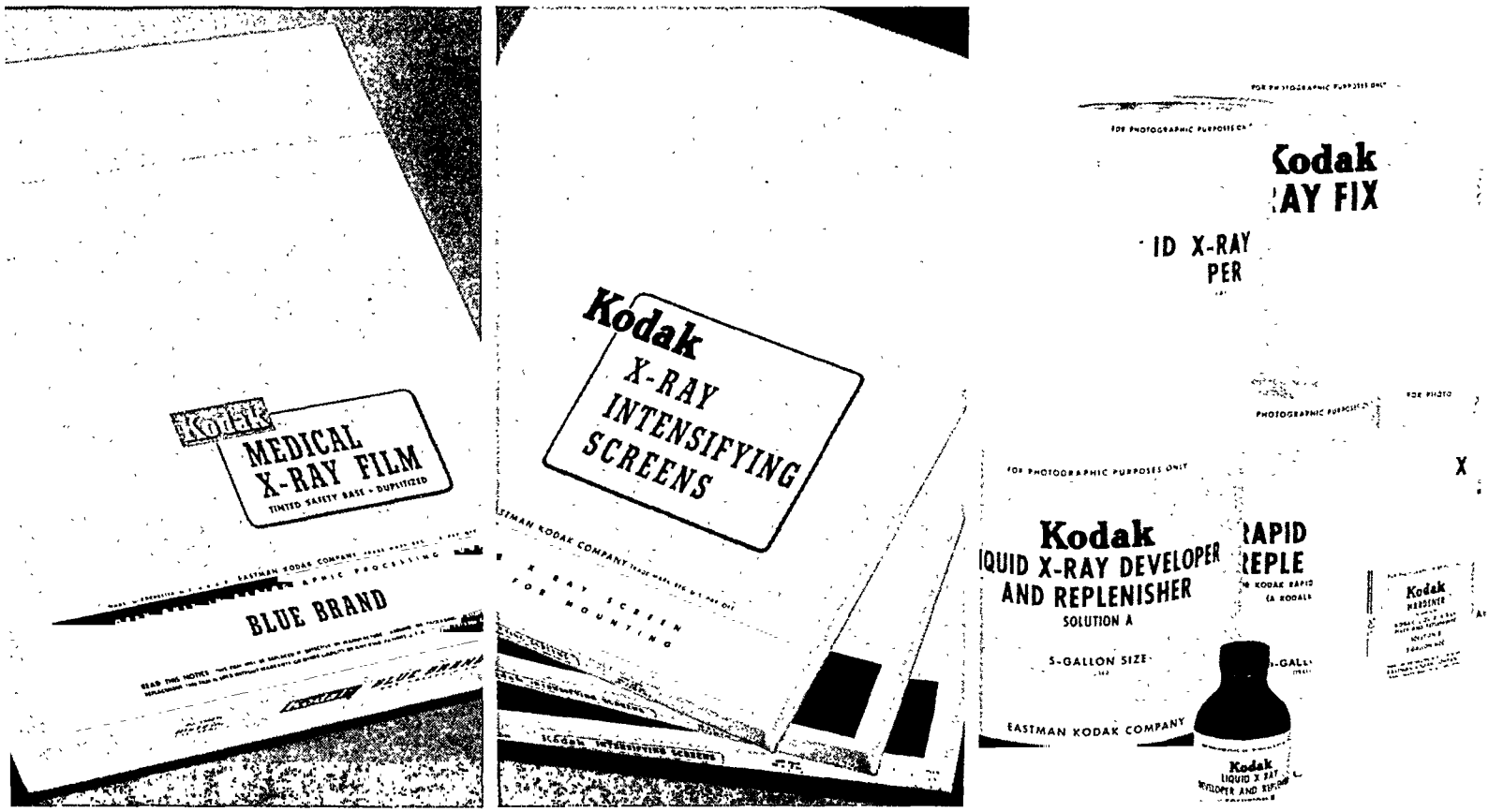
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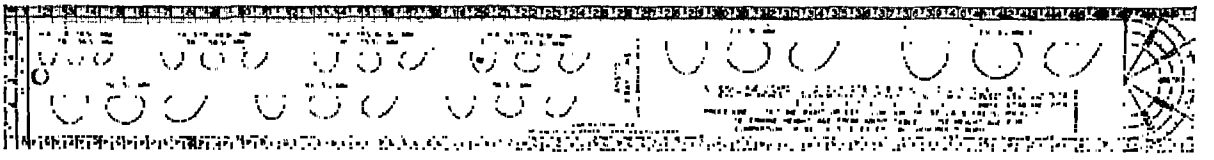
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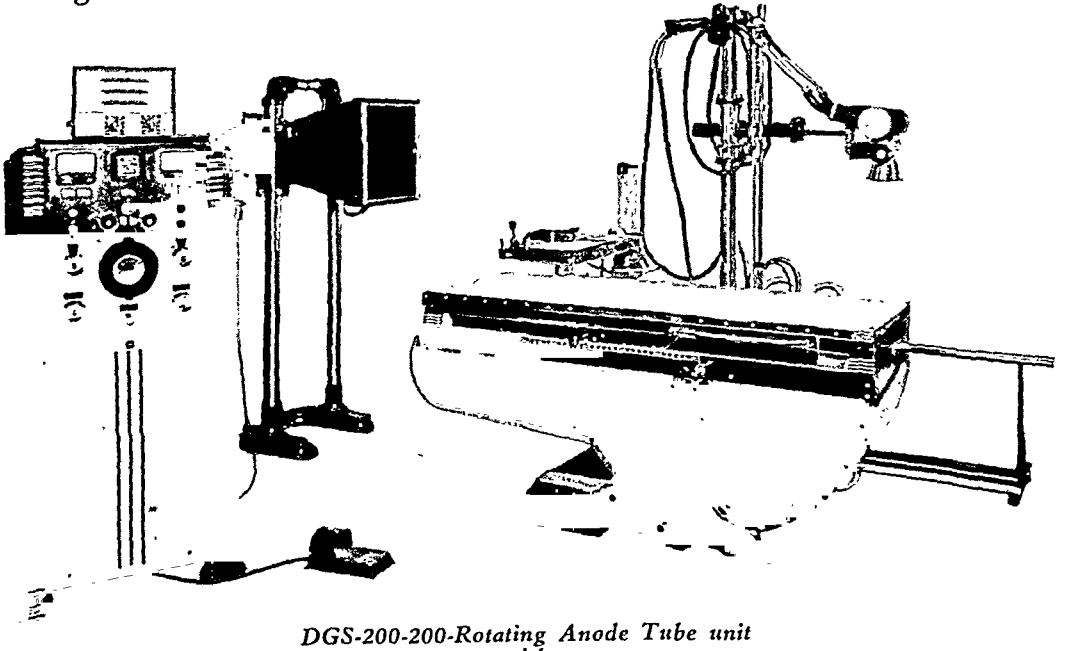
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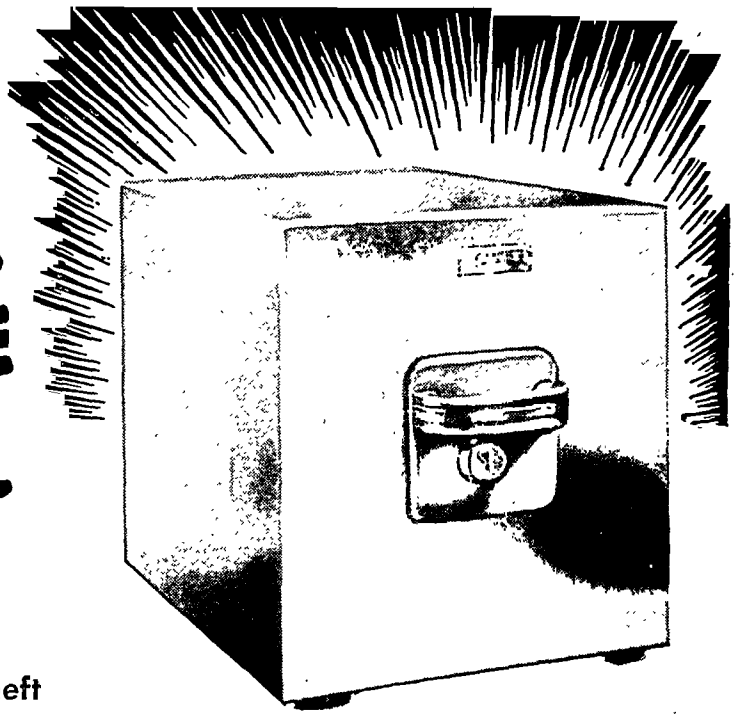


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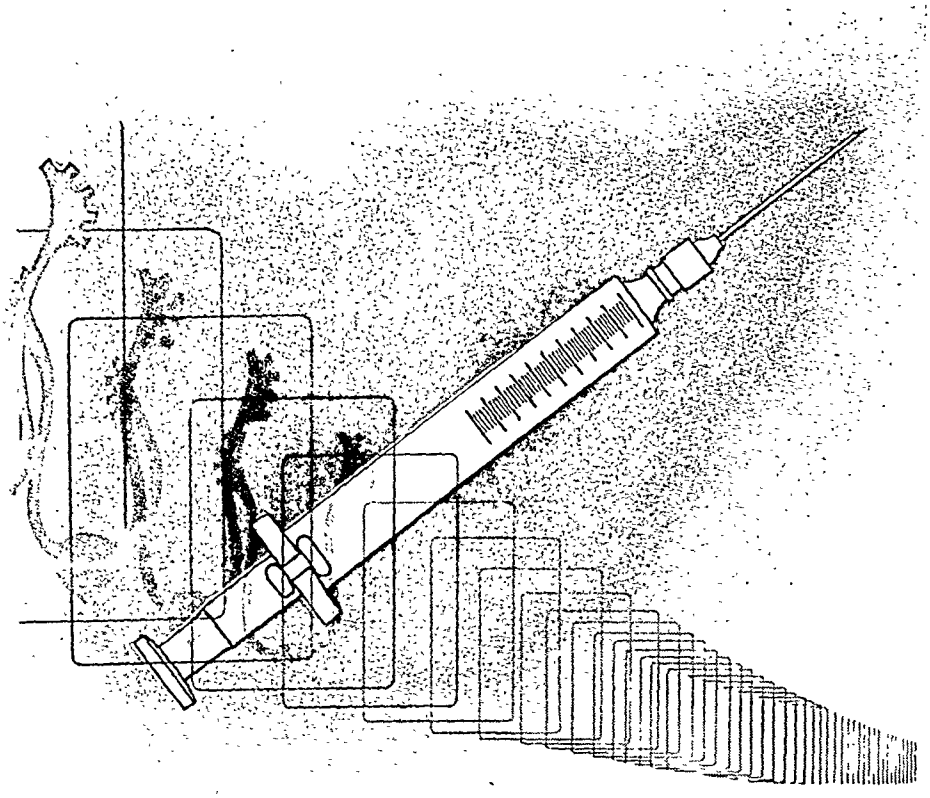
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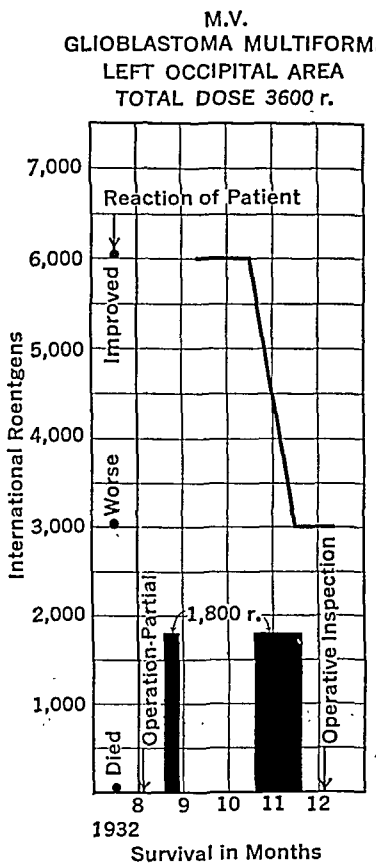
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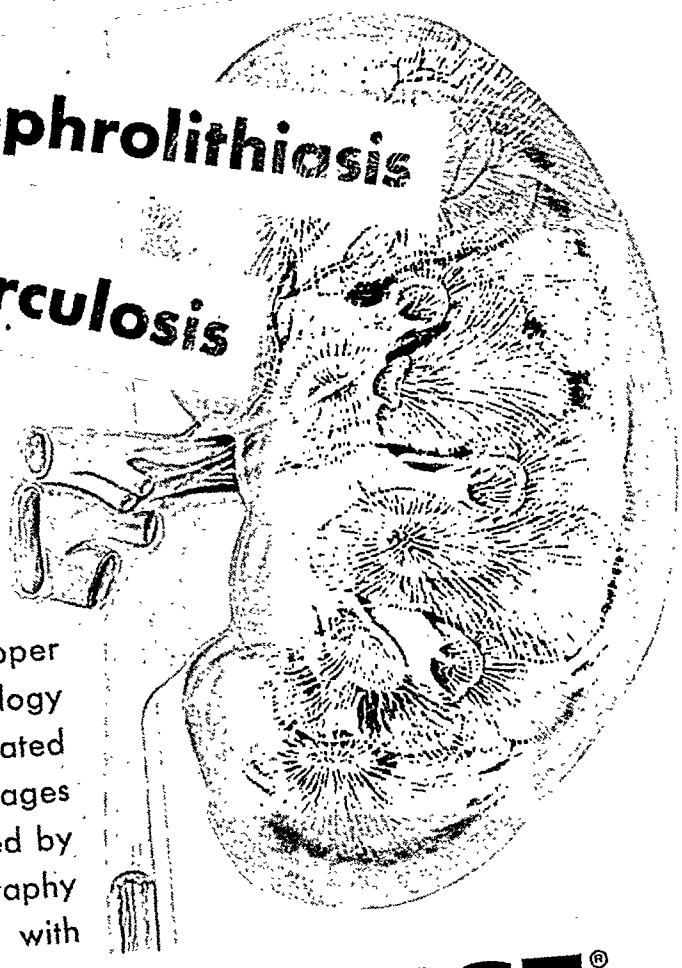


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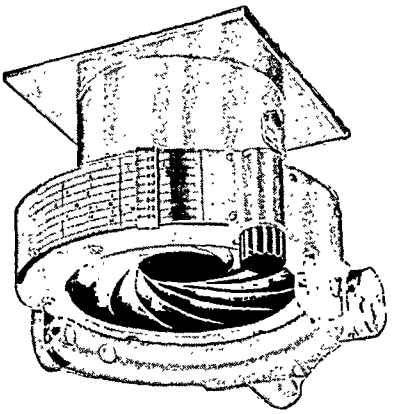
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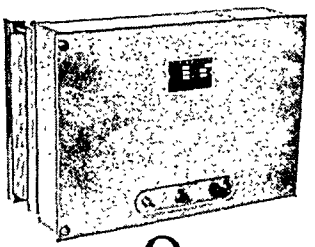
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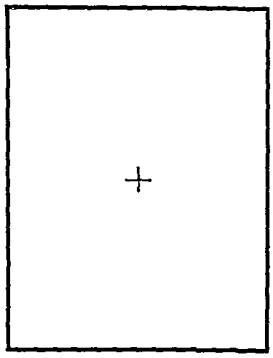
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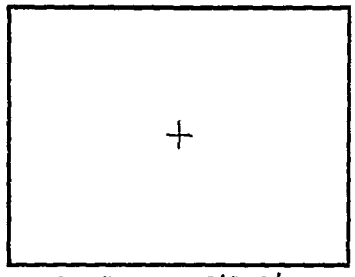
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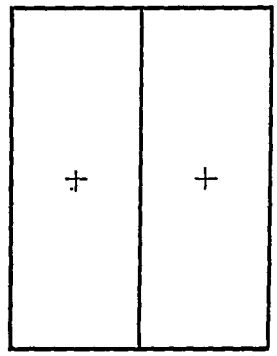
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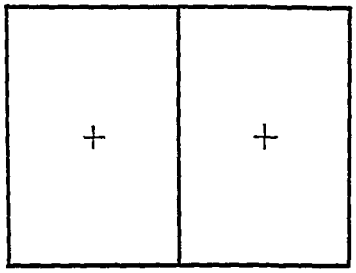
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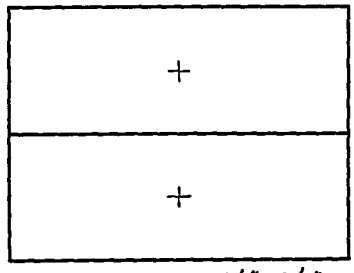
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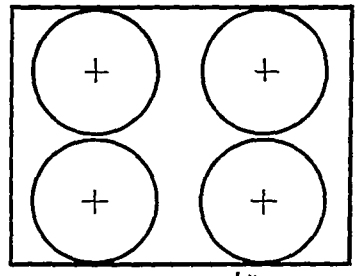
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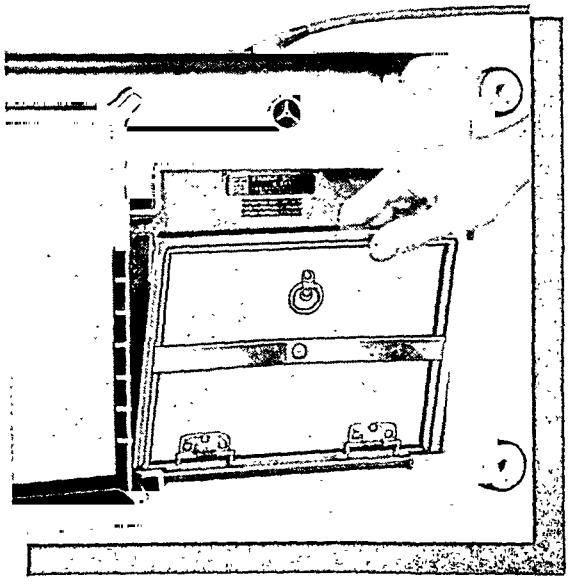
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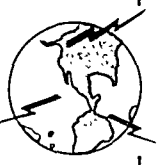
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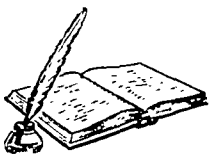
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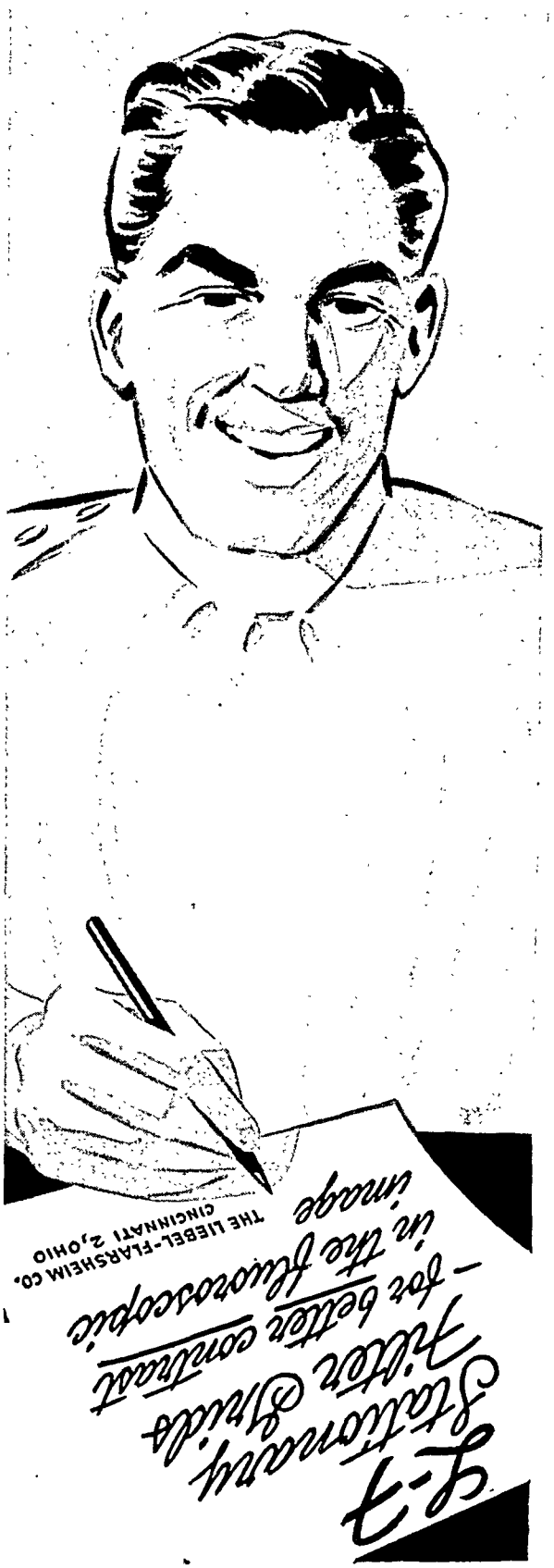
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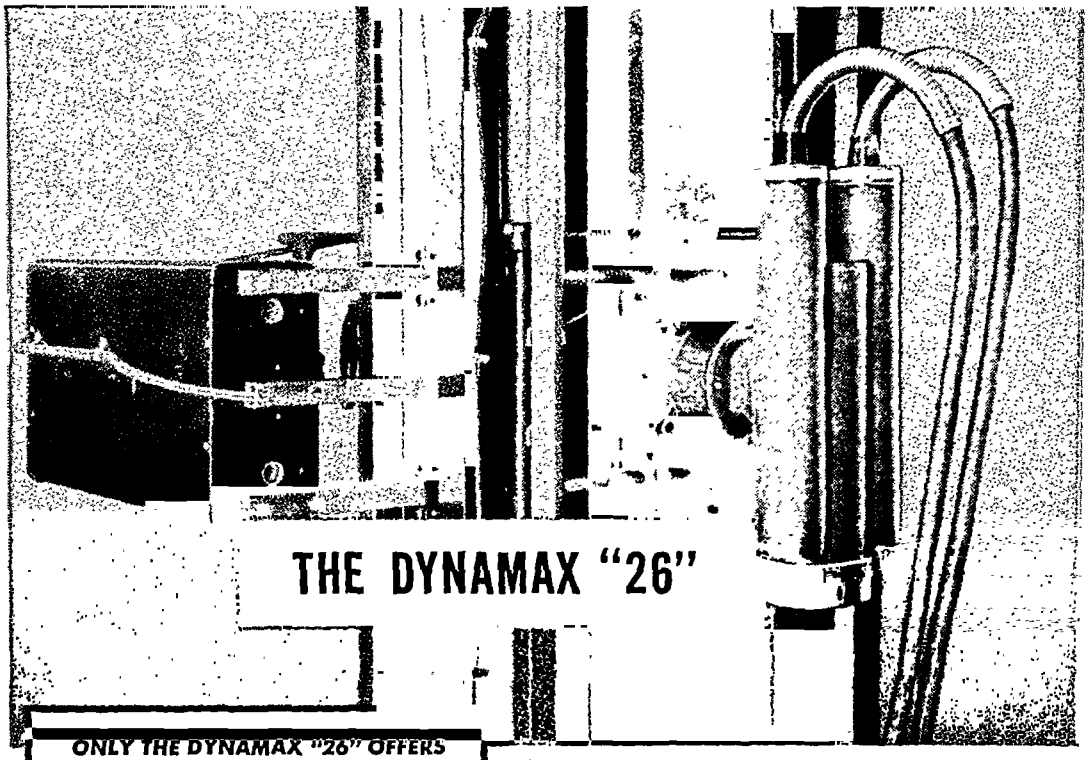
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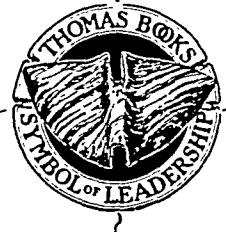
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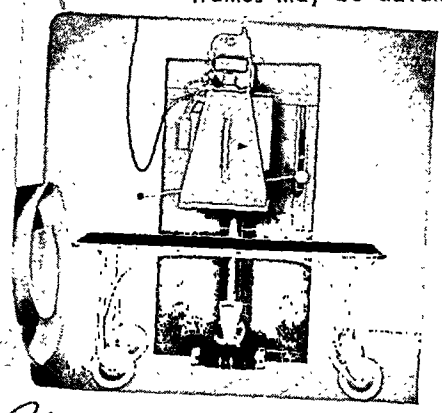
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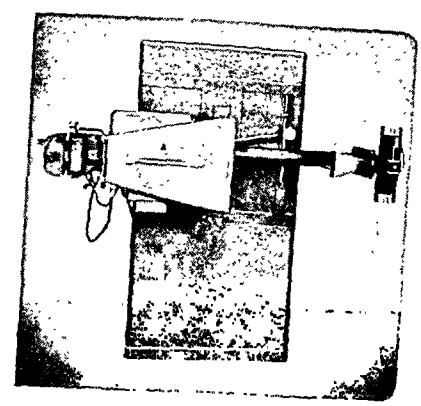
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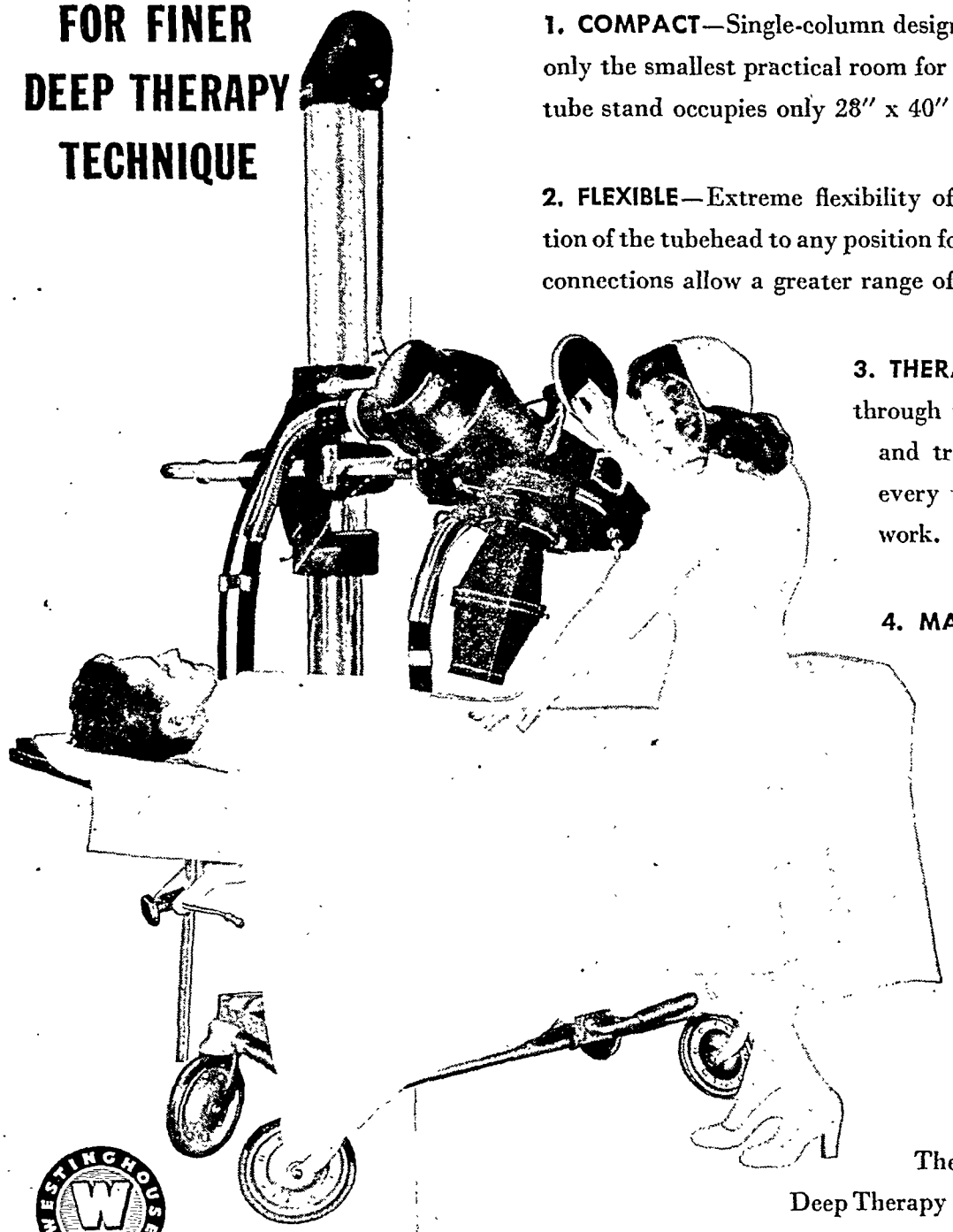
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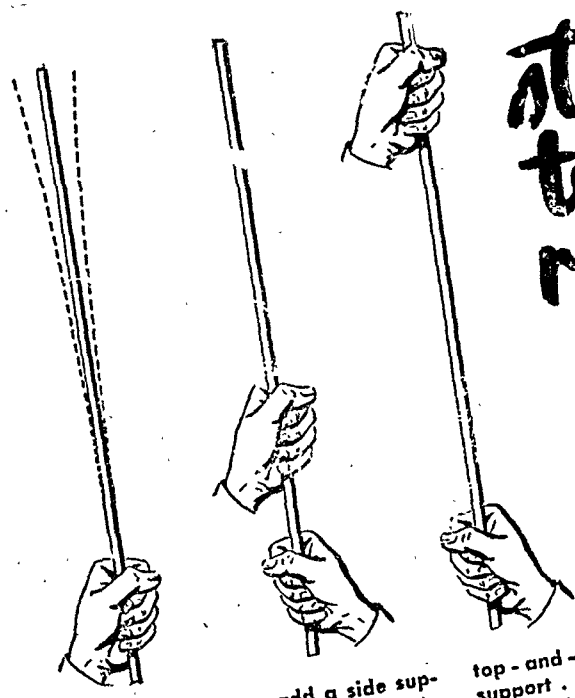
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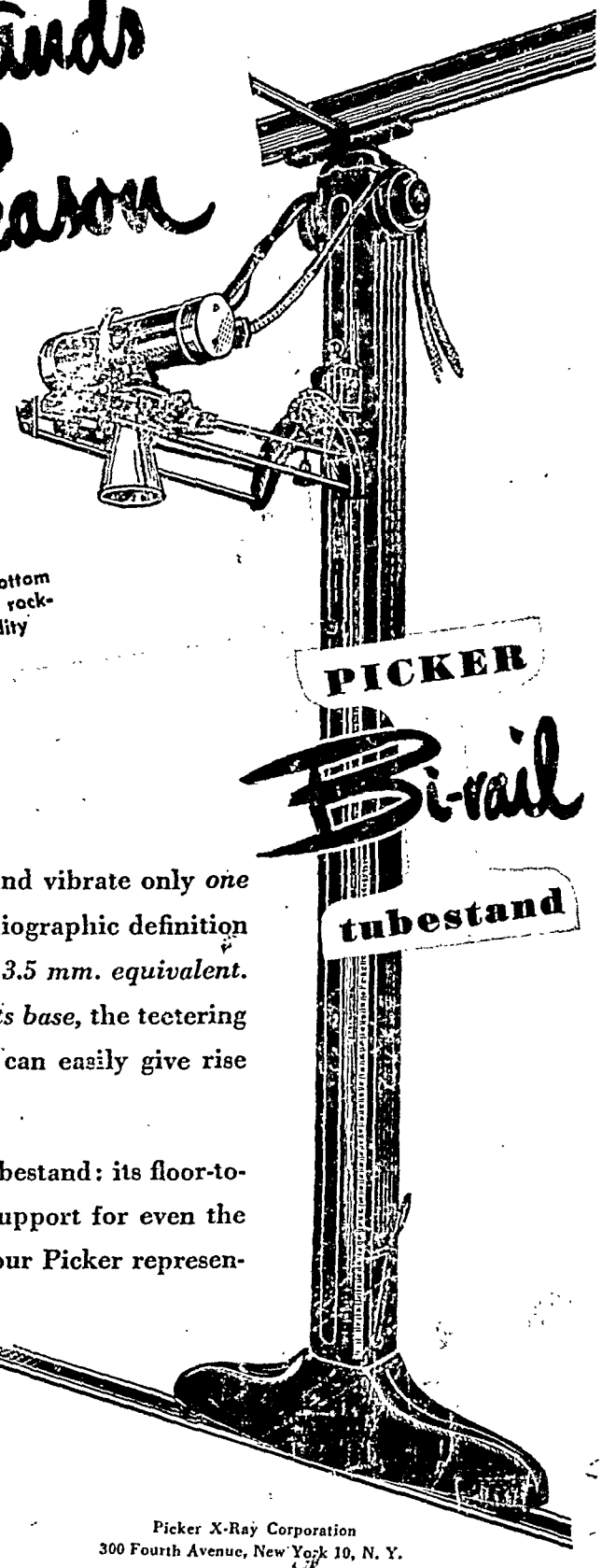
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